TECHNICAL EDUCATION

Technical Education in Evening Schools

BY

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WITH AN INTRODUCTION BY

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PREFACE

THE interest which is being exhibited at the present time in Technical Education has encouraged the writer in the belief that a brief discussion of the subject, in so far as it concerns Evening Schools, will be welcome. There is to be discerned a tendency to under-estimate the value of the work which can be done by students who have been engaged for nine or ten hours a day in earning a livelihood; but though such study may not be carried on under the happiest conditions, it is voluntary, and it manifests latent qualities of energy and perseverance which no one who has regard to national welfare can afford to ignore. Evening Schools have, in this country, grown to considerable proportions, and during the session 1902-3 more than 657,000 students were enrolled. While any dispassionate observer must admit that in individual cases sound and meritorious progress is made, few will deny that this is accompanied by an enormous waste of money, time, and effort. For one who reaps full benefit from attendance at the classes thousands fail. One of the most pressing educational needs

of the next few years, then, is to adapt the instruction to the capacity of a larger number of earnest students, and it is hoped that this little book may help in the removal of those difficulties which tend to reduce the efficiency of Technical Education in Evening Schools.

No attempt has been made to deal with the subject exhaustively. The breadth of the subject, closely connected as it is with Pedagogy, with Sociology, and with Economics, coupled with the fact that the present is a time of unrest, of activity, of experiment, has rendered it necessary to deal only with the larger and more widespread groups of industries falling under the general titles of Engineering, Building, Coal Mining, and Metallurgy. In view of the infinite diversity of schools, with their variety of aims, methods, equipment, and staffing, many problems are merely indicated — not discussed. Where definite criticisms and suggestions are made, certain conditions have been assumed to hold, and whenever possible these have been clearly stated. Ordinary Science and Technical Schools and Continuation Schools have alone been dealt with; Trade Schools have been omitted on account of their expense, their slow progress in this country, and their doubtful value in industries in which the use of machinery is so rapidly superseding hand labour.

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wealth of evidence which it would not have been in my power to adduce. In these circumstances, it appears to me that the less I say the better. Nevertheless, there are one or two points already dealt with by Mr. Creasey which I shall venture to emphasise.

I am afraid we must confess that there prevails a general impression that Technical Education in this country has failed to fulfil the anticipations of those who had most to do with laying the foundations of our present system. I confess that to some extent my own belief is that the country has not received, and is not receiving, a return adequate to the expenditure and effort hitherto devoted to this part of our educational system. At all events, I am afraid that when we study the results obtained in Germany and the United States we must make a confession of comparative failure. Nevertheless, there are some encouraging features. Mr. Creasey informs us that during the Session 1902-3 more than 657,000 evening students were enrolled, and when we remember that attendance at these evening classes is voluntary, and that (unfortunately) but little pressure in the right direction is brought to bear by the employers, this fact alone bears eloquent testimony to the

eagerness with which instruction is desired by the people of this country. This is the more marked when we remember the difficulties with which such students have to contend. The encouragement is little, while the obstacles are great. Let me mention a case, by no means exceptional, which recently came under my notice.

A young man of some eighteen or nineteen years of age, living in this neighbourhood, had to rise about five o'clock each morning in order to descend a coal-pit, in which he was working, by six. Employed all day underground, he returned to his home about 6 p.m., had his evening meal, changed his clothes, and tramped some five miles into this town to attend his evening classes. His classes were over by 9 or 9.30, and it was rarely that he could reach his home again before 10.30 p.m. This task was cheerfully performed throughout the winter months. It is surely the duty of those who have the direction of educational affairs to see that energy and sacrifice of this kind are not expended in vain, and that every facility and help is offered to those who, in spite of such difficulties, endeavour to avail themselves of such opportunities as we can offer. I confess that to me it appears that if

Technical Education has not been altogether as successful as we had hoped, the responsibility lies with the teachers and organisers rather than with the disciples.

Assuming that our efforts have not met with complete success, I will venture to indicate what appear to me to be the chief difficulties which must be overcome before we can attain the results at which we aim.

1. *Want of Co-ordination*

Here, at all events, is a stumbling-block which I trust can now be removed from our path. Hitherto, there has been no relation between the work of Secondary, Evening Continuation, and Technical Schools. Each of these was governed by different, and often unsympathetic bodies. We have now a great opportunity. Whatever may be our individual opinions with regard to the Education Act of 1902, no one can deny that it presents possibilities of co-ordination and graduation which have, until now, been wanting. True, the Education Committees of our County Councils are new to their work, but no one who, like myself, has served on several of such Committees, can doubt either their zeal or their desire to promote the cause of education.

Knowledge will come by experience, and I hope and believe that in the next few years many of the difficulties which have presented themselves under this heading will disappear, and that the scattered units of our present heterogeneous system will, under the wise direction of a central authority, arrange themselves in symmetry and harmony.

2. Our Evening Classes cannot be successful until our Educational Authorities decide that no student shall be admitted until he is able to give evidence that he is in a position to profit by the instruction which will be offered him.

In Chapter IV., Mr. Creasey indicates the steps which have been taken to meet these difficulties in certain localities, but I am afraid that, at the majority of our evening classes, any student is permitted to attend any course he may select. No teacher can be successful under these conditions, and the effect is seen in the dwindling of enthusiasm, and the falling off in attendance as the Session progresses.

I have known cases of evening classes in Mechanics where some of the students appeared to be ignorant of the most elementary rules of Arithmetic, whereas others attending the same class had a sound knowledge of Elementary Mathematics. In these circumstances the unhappy teacher has little choice; he has to

neglect the needs of both the best and the worst students, and address himself to what appears to be the average member of the class. Hence those who require most assistance, viz., the best and the worst, are precisely the ones who receive least attention of all. The result is inevitable: those who understand nothing, and also those who find that they already know everything that is told them, cease to attend, and I believe that the irregular attendance, of which unfortunately we have overwhelming evidence, is chiefly due to this cause. For each class a standard should be fixed, and care should be taken that those below are rejected, while those above that standard should be promoted to a higher class, or, if necessary, a special class should be formed for their benefit.

Motives of economy naturally prompt the members of our Education Committees to regard large classes with favour, but this is false economy, both from an educational and a financial point of view. Small classes with regular attendance will yield a greater return, whether regarded from a grant-earning or an educational standpoint. *Regular attendance is the best evidence of sound organisation.*

3. Another serious cause of weakness is the absence of thoroughly organised courses of

instruction. I confess I do not see why the students at a Technical School should have greater liberty in their choice of studies than the undergraduate at a University. It is the habit of most educational committees to give emblazoned certificates to all and sundry students who have acquitted themselves with any degree of credit in any and every subject. It is part of my duty to sign hundreds of such certificates annually, and I cease to wonder that employers attach little or no importance to these official-looking documents. If, however, these rewards were only presented to those who had successfully completed some organised scheme of study, they would have a real meaning which would soon be appreciated by men of business.

In Chapter IV., Mr. Creasey gives many examples of such organised courses as they exist in Birmingham, Bradford, etc., and I trust that similar courses, modified to suit the requirements of each particular district, will be established in all the Evening Technical Schools throughout the country.

I would ask attention to the fact that nearly all the difficulties I have so far indicated arise from the lack of sufficient control and direction. Take the case of a lad who has decided to join a Technical School. He

studies the Prospectus, and thinks that he would like to attend a course in this or that subject. He has little guidance as to the value of those subjects in themselves or their relation to other studies. He obtains the necessary forms, pays the small fee demanded, and presents himself at a course of lectures which possibly may be of little, if any, advantage to him.

Mr. Creasey well illustrates this point when he states that a study frequently selected by the students when entering a Technical School is that of Electricity and Magnetism, a subject which should certainly be taken at the end, and not at the beginning of any Physical course. What is wanted is more *guidance.* I would suggest that in all Technical Schools certain of the Staff should be appointed to act as Advisers, and that all students should, on entering the School, be directed to consult the Adviser appointed to deal with the group of subjects in which he is interested. It should be the duty of the Adviser to ascertain, so far as is possible without formal examination, the object aimed at by the student; also his ability and knowledge. The forms of application should be filled up in the presence of the Adviser, and only accepted when they have received his approval. These officers would

have to be selected with care; each should receive a definite salary, and I believe full value would be obtained for the money thus expended.

4. One special difficulty remains to be considered, viz.: the training of Technical Teachers.

At present I am afraid that our Teachers in the Evening Technical Schools may be divided, roughly, into four classes:—

(*a*) Those who have knowledge of the practical applications of what they teach, but little knowledge of teaching.

(*b*) Practised and trained teachers who know little as to the practical applications of their subjects.

(*c*) Capable teachers with sufficient technical knowledge.

(*d*) Those who know little of teaching or of their subject.

I am glad to say that Class (*d*) is a small and diminishing one. I am afraid, however, that the great majority of our teachers fall in Classes (*a*) and (*b*) rather than in Class (*c*), and it is difficult to see any way of escape. If, however, we are to receive full value for the money spent on Technical Education, this matter will have to be taken seriously. We have spent enormous sums of public money on

the preparation of our Primary Teachers, and a large amount of private money in the case of Secondary Teachers; but, so far as I can see, the Technical Teacher is supposed to fall, like the dew, from heaven, without thought or effort on our part. As a matter of fact, his is the most difficult case of all; he has to be at once an engineer or chemist, a teacher and a tradesman. He has in most cases no recognised *status* in the teaching profession; his emolument is small; he has no authority over his students except that which he obtains by his own force of character, and it is to me a matter of surprise that, considering the nature of the rewards we can offer, we are able to secure so many men capable of playing such varied parts.

The training of the Technical Teacher is, I suppose, one of those difficult problems which must be left to a future generation; in the meantime, our best hope of progress is by increasing the *status* and the rewards in such a manner as to make the profession of Technical Teacher at once attractive and lucrative.

In conclusion, I wish to say that this work of Mr. Creasey's offers real assistance towards the solution of many of the difficulties which now present themselves.

Of one thing there can be no doubt, it

appears at a singularly opportune time. The control of our Technical Schools has passed into the hands of new governors, who, as a rule, are actively engaged in the affairs of civic life, and upon whom many and very varied additional responsibilities have been cast by the Education Act of 1902. Granted that such men have the desire, it is evident that they can have had little opportunity for the study of many of the difficult problems which arise in connection with Technical Education. To such men I with confidence recommend this book. They will here find an admirable summary of our present position, and they will also be able to consider the nature of the experiments performed by educational bodies other than their own.

More especially do I hope that this book may come under the notice of employers of labour. It must be confessed that, with certain honourable exceptions, the attitude of the employers in this country compares unfavourably with that of their competitors in the United States. If we could but convince the Captains of Industry that the education of the employé benefits the employer, the difficulties which we meet with would rapidly decrease.

I am one who believes that in the brains of

our working-men we have a national asset whose potential value it would be difficult to exaggerate; a neglected coalfield into which our Technical Schools are at present engaged in sinking what we may term borings, rather than shafts.

E. H. GRIFFITHS.

TECHNICAL EDUCATION IN EVENING SCHOOLS

CHAPTER I

TECHNICAL EDUCATION

NOTHING is more striking in the history of the past century than the extent to which scientific discovery has revolutionised manufacture, and correspondingly complicated the operations of commerce. Rule of thumb and blind reliance on the faculty of guessing have given place to processes conducted on a scientific basis. Competition has rendered economy of production a matter of paramount importance, and there has arisen the necessity for those engaged in industrial operations to have an intelligent knowledge of the principles underlying their trade, based on as high a level of general education as can be secured.

In this country the agencies for providing such training consist of Evening Schools for those who are engaged in bread-winning during the day, and full-time day courses, at Technical and University Colleges and the Technical Departments of Universities for those who can devote the daytime to study.

The former comprise Continuation Schools, in which the basis of instruction is the three " R's," but which is not necessarily confined to these, and Science and Technical Classes working on syllabuses (occasionally modified) of the Board of Education and of the City and Guilds of London Institute. The Continuation Schools stand at the base of the evening educational fabric, and their true function is to remove defects of early education, and to act generally as a connecting link between the Elementary Day School and Higher Institutions which provide evening instruction. How far this object is fulfilled will be considered in Chapter II. The real purpose of this book is to discuss the function of Evening Schools of all kinds in relation to Technical Education, and it will be contended that such schools should be, but are not, efficient members of a well-articulated system. As it will be necessary to deal with points which really affect evening classes only indirectly, the educational standpoint from which the subject is regarded must be defined.

Professor Findlay defines Education in the following terms :—

" The adult portion of the community, organised in the forms of the Family, the State, the Church, and various miscellaneous associations, desires to promote the welfare of the rising generation. This it seeks to do by the employment of certain deliberate modes of influence, as an addition to the inevitable influences of circumstance and environment that operate upon all human life. These specific influences are called Education."

This definition is wide enough to include all forms

of educational effort, though it is restricted later by the statement that :—

"When you have entered upon your duties as a citizen, your education, in the proper sense of the term, is ended."

What follows is "culture of the mind," and presumably starts when a man commences to earn his own livelihood. This may be after apprenticeship, or at the conclusion of a University career. The Evening School, however, will be regarded as one of the institutions in which "these specific influences" are being brought to bear upon whoever comes within its walls, and in it the canons of educational science, so far as they have been established, must be obeyed.

Sir Philip Magnus[1] defines Technical Education as

"The special education, the object of which is to train persons in the arts and sciences that underlie the practice of some trade or profession."

It therefore not only involves the intellectual training implied in the word Education, but endeavours to obtain this through the study of subjects bearing upon the occupations by which members of an industrial community gain their livelihood. In *general* education the material to be instructed is nearly all of the same nature; in *technical* education that material varies widely in different industries, and in the various grades of men engaged in them. Classification in technical education is determined not so much by age as by present occupation and prospective career. And as the tendency in general education is to smooth the way for genius by the award of scholarships, so

[1] "Encyclopedia Britannica."

also the extent to which a man may proceed in technical education, owing to the cheap and liberal provision of it, depends more and more upon his ability, and less and less upon the accidental circumstances of his birth. This emphasises the necessity of linking the Evening School with the institutions from which a student may come, and with those to which his natural aptitude may entitle him to proceed.

Every well-organised *school* presents certain features. In the first place, the curriculum is carefully drawn up so as to be suited to the age and capacity of the pupils at each particular stage. In the second, the curriculum exhibits a "balance of studies," so that a broad basis of training and knowledge, upon which subsequent specialised instruction may be developed, is secured. In the third, there is intelligent correlation between cognate subjects. In the fourth, the teaching recognises the psychological phenomena which are of value in education. These factors become perhaps of less importance — certainly are less marked — in institutions which take students "from the age and standard at which the scholar becomes the student, acquires rather than receives, and works with the fuller responsibility of adolescence and the more specialised scope required as a preparation for the occupations of mature life and the exercise of active citizenship."[1] But the limitations of time demand that instruction in the Evening School should have all the assistance that the Art of Teaching or the Science of Education can give.

[1] Prefatory Memorandum, Board of Education Regulations for Evening Schools, 1904-5.

Technical Education in Evening Schools has at least one great educational merit. It satisfies, in a marked degree, the doctrine that good teaching utilises the pupil's experience to the fullest extent. This doctrine furnishes a basis of attack upon a fallacy which is, unfortunately, too prevalent: the introduction of so-called technical subjects into Elementary and Secondary Schools. Many of these subjects are, of course, not "technical"; if they are, they have no right to be introduced. Manual Instruction, for example, has a strictly educational function, but Machine Drawing has not. The Elementary and Secondary Schools are concerned with giving the most complete *general* education possible in the time the child can devote to it; and the time is all too short for this purpose. *Technical Schools seek to manufacture efficient members of the industrial army out of those who have already in them the making of intelligent citizens.* And any intrusion of technical subjects into the Elementary or Secondary Day School curriculum is disastrous to both *general* and *technical* education. The increased demands which the conditions of modern life make upon leaders of the community render it extremely undesirable that the *basis* of special knowledge should suffer reduction.

But there are educational objections quite apart from those of expediency. The teacher must develop his subject by reference to the actual experiences of his pupils, and these experiences are so narrow that it is frequently difficult to secure clear notions of subjects falling within the scope of general education. How much greater, then, must be the difficulty of

dealing with industrial processes which are altogether outside the pupil's ken! Such information can find no proper place in the mind-content of the pupil, though, like the propositions of Euclid, it can be "got up" in a manner calculated to deceive the very elect. And its introduction into the school curriculum not only disregards the first essentials of education, but involves the assumption that the brain is a mere lump of putty, upon which impressions can be stamped at will. Effective teaching must have regard to the environment of the pupil if the various sense impressions are to be welded into a rational and permanent mental equipment.

As against this view, it may be urged that such schools are provided with school workshops, and that every effort is made to show the bearing of the theoretical instruction upon practical problems. Mimic warfare is all very well in its way, but it is not the real thing. The question of cost, of time, of economy of production cannot present itself so vividly in the school as in the factory; the conditions are wholly unnatural.[1]

Another objection may be raised on the score of age, and this may perhaps go home to many who may not so fully appreciate an argument based on the doctrine of apperception. The breadth of outlook necessary is not to be found in fifteen-year-old

[1] Visits to Works, Factories, and Mines are only really profitable to those who have had experience. They tend to bewilder the beginner. For a strong condemnation of the ambitious aim of the school workshop, see an article by Professor John Goodman in *Page's Magazine* for December, 1902.

school-boys. There may be much inequality in this respect, but it is certain that mental development in some of its forms is far more rapid after obtaining the measure of independence which leaving school implies. The seriousness of life only becomes apparent to a lad when he is actually launched upon his career.

It is not intended to maintain that Elementary and Secondary Schools should have no regard to the subsequent occupations of their pupils. The curriculum may indeed have a strong bias, and should be scientific, but should not include applied science. All that is asserted is that while Technical Education must have regard to the condition of Elementary and Secondary Education in any particular district, it stands separately, and is altogether outside the scope of either.

If this special training is outside the scope of the ordinary Day Schools, the questions at once arise: How, when, and where is it to be given? And the answers involve a much closer inquiry into the nature of the training than has yet been undertaken.

The changed condition of industry has been said to have created the need for trained men: this point requires further explanation. In the early days of Technical Education, many people seemed to think that their object was to make better workmen, and it was no small disappointment to them to find that the workmen did not particularly want to be trained —unless they obtained more money thereby. The comparatively small proportion of men who show a desire for training is responsible for the opposite view that the main object was to produce "Captains of

Industry," and leads to the cry that we must follow Germany and America in attending to Higher Technical Education.

The former idea is closely associated with the one that Technical Education is rendered necessary by the breakdown of the apprenticeship system. This is not so. The apprenticeship system has broken down in most cases because of the introduction of machinery, and the consequent division of labour. The need for skilled hands is now rapidly disappearing, except in the artistic crafts, and in minor branches of the constructive trades. On the other hand, the operations of the workshop and the factory have become more complicated, more exact, and in a number of cases more dangerous. They require supervision by men who understand them, men who know how to conduct them safely and economically. Theoretical and practical training are complementary, and it is men who have received both forms of training that are needed in industry.

It is unfortunate that the value of theoretical training should have been overrated: from it far too much has been expected. No one imagines that the Law Schools can turn every man who goes through them into an accomplished advocate, nor are the Medical Schools exclusively engaged in producing medical geniuses. Yet judging from letters that have appeared from time to time in the technical press, it would seem that the introduction of a trained man into the works was expected to revolutionise the methods, and bring the dividend up to a percentage never before attained.

It cannot be seriously maintained that the

accumulated experience of even an untrained man in (say) an engineering works goes for nothing, any more than that the theoretical training is of no value whatever. It must, however, be admitted that the trained man has a better knowledge of general principles, exercises a more critical attitude towards problems that arise in practice, and possesses a wider horizon. He has the advantage of his untrained *confrère* in that he will more readily grasp the bearing and value of improved methods in associated industries, and exhibit greater facility in applying them to his own. It is in this direction that the value of theoretical training undoubtedly lies, as well as in the better control of the exact processes that have superseded the rule of thumb methods of former times. At the second annual meeting of Messrs. Clayton & Shuttleworth, Ltd., Lincoln, on April 16, 1903, the Chairman said:

"Keen competition necessitated their having every year machines of greater efficiency without obtaining a corresponding increase in sale price. That was an evil from which all manufacturers were suffering, and the remedy was to be found in the cheapening of the cost of production by taking advantage of every new invention and discovery."

One of the reasons why Technical Education has so often received less favour than its importance demands is the failure carefully to adapt the means to the end. Students in all stages of preparation, of all capacities, and with diverse objects in view, have been herded together in evening classes which owed their inception rather to the fortunate presence of a particular teacher with particular qualifications than

to any clear-sighted interpretation of, and provision to meet, requirements. And in all the writing and speaking on this subject in the country for a number of years there has been much confusion between the different types of students and their several needs. Advocates of training of some sort there have been in plenty; though in but few cases has there been any attempt to define the particular needs of particular students.

An examination of the organisation of any industrial concern reveals the fact that, apart from the ordinary workman, there are several grades of officials who require training of more than one sort, and a true estimate of the kind required for each is necessary before the question as to how it is to be acquired can be approached. A rough division into minor and major officials will probably be found sufficient in discussing requirements. Thus, in Mechanical and Electrical Engineering there will be foremen, under-foremen, draughtsmen, etc., in the former group; heads of departments, works' managers, chief draughtsmen, etc., in the latter. It will be understood that as a rule in small works men of the minor status occupy positions corresponding to those of the major group in larger works.

The minor group in the Building trades includes under-foremen, foremen, clerks-of-works, etc.; the major group Master Builders, Civil Engineers and Architects.

In Coal Mining, firemen and overmen will fall into the minor group; under-managers, managers, and colliery engineers generally into the major group.

The Metallurgical and Chemical industries similarly contain two groups; the major positions are those of chemist and works' manager.

The minor group should be composed of men whose extensive practical experience is combined with such theoretical knowledge as will render the processes and operations they control intelligible to them, and as will enable them to follow and apply current invention and discovery so far as it concerns their own branch of the trade. This latter consideration assumes that the organisation of the works affords free scope to the inventive faculties of all employés, whatever their status—a point that seems to be more fully appreciated in America than in this country.[1]

The major group will be composed of men of considerable practical experience, coupled with deep scientific knowledge, and a wide outlook upon human affairs. The general education of the lower grade must be as high as can be attained; for success in

[1] See Reports of the Mosely Educational Commission:

"In the Baldwin Locomotive Works the piece-price has not been changed for some years, and the man gets the advantage of constantly improved plant and process," p. 189.

"At the National Cash Register Works I saw machines in operation which take 103 separate cutting and boring tools, and I was assured that these machines were all evolved by their own employés. I believe that the American employers, by the adoption of the wise policy of giving encouragement to men of inventive minds, by rewarding those who suggest improvements in machinery, and by giving increased remuneration to those who operate such machines, have done, and are doing, much to increase their trade and to menace that of British producers who are in any way brought into competition with them," p. 392.

the higher grade a liberal education is indispensable for all but the exceptional man.

It is obvious that as things at present stand, only the latter class can have the training afforded by several years' attendance at a Technical School or University; but for them it is essential.

Members of the former group are generally drawn from a class whose parents have been unable to keep them at school longer than fourteen or fifteen years of age, and for whom two or three years at a Technical School would have been out of the question. The only course before them is to attend evening classes, and with this patent fact in view, it is astonishing to read the wholesale condemnation with which such classes occasionally meet.

Criticism of evening classes often arises from failure to appreciate the conditions under which they operate; and it will be pertinent to the subject to consider some of the objections at this stage.

That which has the most validity emphasises the fact that the latter end of the day, after nine or ten hours in the workshop or factory, is not the best time for study. This is perfectly true, but it is a case of "Hobson's choice." If the employers are prepared to follow the course adopted by the L. & S.-W. Railway Company (see p. 128), a more suitable time could be arranged. And until they are, it would not surely be contended that evening work should be abolished. Moreover, it is an indisputable fact that excellent work can be, and is, accomplished by evening students—too good to be sacrificed for the sake of a counsel of perfection.

The second objection is on the score of health. Thus, Mr. Dugald Drummond "is satisfied that the strain, both physical and mental, to which a growing youth is subjected, is likely to be dangerous to his health, if he is taxed by evening classes after a day's work in the shops";[1] but he makes an exception in favour of drawing classes. With all respect to Mr. Drummond, is this criticism capable of general application? The writer has spent twelve years in various capacities in all sorts of evening classes, and he cannot call to mind half-a-dozen cases of breakdown. At the same time, he can cite quite as many examples which have resulted from cramming for Civil Service and other examinations. Certainly there is danger in excessive devotion to study everywhere, and at all times. But it is a preventable evil, and one which is practically abolished when the studies are carefully regulated.

Moreover, there is a point to which due weight is not always given. The classes are only held during the winter months, when the nights are often cold, wet, and cheerless, and when the temptation to seek shelter and companionship may lead to far more harm—mental, moral, and physical—than is likely to result from attendance on two or three evenings a week at the Technical School. The fact that harm in the latter case is possible should be a greater incentive to the careful organisation of evening work, so that time and effort may be alike economised.

This leads to another objection that is often raised: the unsuitability of the instruction to the needs and

[1] *Technics*, Feb., 1904, p. 152.

capacity of the students. Discussion on this matter must be deferred to a later chapter, but it may be observed here that it is merely a question of local organisation. What has been brought to a high pitch of organisation in this country is the distribution of financial aid; the equally important problem of the best use of it, except in a few instances, still awaits solution.

In *Technics* for January, 1904, Professor Wertheirner refers to the good work—though of an elementary character—which can be done in evening classes. Surely its elementary nature is no reproach; is it not rather an acknowledgment that evening classes *can* accomplish the work that falls within their scope? If evening classes would only confine themselves to good work "of an elementary character," many criticisms would fall to the ground. It is the attempt to combine instruction for the average man with that for the genius that leads to half the reproaches which are levelled against the classes, and hides their real function beneath a mantle of showy make-believe. Evening classes are here, and here they will be for many years to come, and it is a matter of much more importance to enable them to fulfil their function in Technical Education than to waste time in raising trivial objections.

From what has been said, it will be gathered that the first requirement of evening classes is to provide instruction in the principles, scientific or artistic, underlying their various occupations for those who will be unable to complete their studies at the Day Technical College. The course should be complete,

adapted to the needs of the industry and the capacity of the students, and so arranged as to secure the most rapid progress with the greatest economy of time and effort.

It is not the business of the Evening Technical School to remedy defects of early education. This has been defined as falling within the scope of the Continuation School, and the organisation of such schools will be shown to be one of the most pressing educational problems now awaiting solution.

There is another function of the Evening School in Technical Education. Large numbers of students attend evening classes who ultimately complete their education at the Day Technical College or University. In order to obtain some idea of the relation of the Evening School to this type of student, the methods of entering the various industries must be discussed.

There are three ways in which a lad whose parents can afford it can be put through a course of theoretical and practical training in Engineering. The first is for him to go straight from school into the workshops to serve an apprenticeship of four or five years. During this period he may or may not attend evening classes according to his inclination, opportunity, or the influence of his employers or guardians. The second method is to send him to a Technical School or University for two or three years, and then into the workshops for a shortened apprenticeship of three years. The third or "Sandwich" system is a combination of the two. The lad alternates between the workshops and College, either in half-years or in any way that the ingenuity of man can devise.[1]

[1] See p. 20.

In the first system, evening classes are of the utmost importance; in the second they are not required; in the third they are of use only where the alternations are other than half-yearly.

As opinion is at present sharply divided on the merits of each scheme, it may not be out of place to discuss the *pros* and *cons* as they present themselves to the writer.

To begin with, there are one or two general principles that appeal to the educationist more than to the Engineer. The first is that all teaching must keep in view the mind-content of the pupil; new ideas can only be assimilated in so far as they associate themselves with ideas already in the pupil's mind. How the engineering lecturer is to make himself intelligible to those whose knowledge of actual workshop conditions is largely visionary is a problem whose solution is best left to the advocates of the second method: School-College-Works.

The futility of the school workshop to supply this deficiency has already been noted (p. 7). Striking testimony to the same effect is furnished by E. Vanclain, Superintendent of the Baldwin Locomotive Works, U.S.A. He says:[1] "No one but those who employ labour or operate large machine shops are aware of the deplorable failures of those who enter their works from the Mechanical Training Schools."

The second principle emphasises the importance of deferring instruction until the maturity of mind which comes with years will enable the pupil to take

[1] *Cassier's Magazine*, April, 1902, p. 510. The argument is in favour of indentured apprentices and proper supervision in the works.

full advantage of it. Everyone knows that grasp, breadth of view, earnestness of purpose, and all those mental attributes which make for success in life, are associated with a development of the brain not often found during boyhood. The immensity of the problems which the engineer has to face must fail to appeal to the half-developed school-boy in their due significance. On this matter the evidence of Professor J. A. Fleming is emphatic. Speaking from eighteen years' experience at University College, London, he says: [1]

"My experience has been that a considerable proportion of those who enter a college straight from school for the purpose of passing through an engineering course, not only come very inadequately prepared to benefit by professorial teaching, but bring with them a school-boy habit of mind. . . . Moreover, until a young student has developed sufficient character and power of study apart from the control existing in schools, he may, and often does, waste much time, and is not awakened to the necessity of taking the utmost advantage of his opportunities. I have found that young men who have been placed on leaving school in an engineering works as pupils, and who, after two years or so, return to college to take up the theoretical part of their subject, work much better, and are more eager to make the best use of their college time than a school-boy of sixteen or seventeen coming straight from school to college."

He advocates one year College for pure science, two years in works, two years in College, and then back to works.

[1] Letter to the *Times*, April 15, 1903.

This principle, again, is in opposition to the School-College-Works system; and both, while not unfavourable to the Sandwich system, indicate clearly defined advantages offered by the first, or School-Works-College plan.

Setting aside for a moment the two general principles enunciated above, certain points connected with the first and second systems may be discussed, as it is disagreement upon these that has given rise to the third system.

On behalf of the first system, it may be urged that the lad is more pliable, more amenable to the stringent discipline of the workshop at sixteen or seventeen than he will be at nineteen or twenty. There is a growing tendency among employers to insist upon their pupils keeping the usual workshop hours, and the first system enables parents or guardians to decide early whether or not their lads are capable of standing the strain of industrial life.[1] Meanwhile, the lad will not only be accumulating practical knowledge that will make his subsequent theoretical instruction intelligible, but he will be deferring that instruction until his mind is able to grasp the broader scientific and economic principles involved.

An objection that must be treated with respect on account of the standing of those from whom it emanates, is based on the apparent danger of a break in study between school and College. Thus in the discussion on a paper by Dr. J. T. Nicholson read

[1] If you wish to make a boy an Engineer, inquire into his physique and stamina. If these are lacking, put him in a place where he will be out of a draught.

before the Manchester section of the Institution of Electrical Engineers, Dr. E. Hopkinson pointed out that for a boy to leave school at about the age of sixteen, and to enter a workshop with the idea of returning to school or College after an interval of two or three years, involves a break in the scholastic course, and in habits of learning, which often has disastrous results. But it may fairly be claimed that if "habits of learning" are so easily lost, then the application which is a necessary factor of success in any walk of life is absent.[1] And the "break in the scholastic course" is a bogey which only appears to those who persistently refuse to accord due recognition to the value of evening classes.[2]

The difficulties which this or that individual raises against one or the other of the first two systems, appears to be driving Engineers over to the Sandwich system as embodying most of the advantages, and fewer of the disadvantages of either. At the Engineering Conference held in London in June, 1903, many speakers expressed their approval of this method, which has many advantages to offer to those lads who are born in such happy circumstances that they can plan their training irrespective of its cost. If the "Sandwiches" are half-yearly, the necessity for evening classes for this type of student would be entirely abolished. But upon this matter there is at present much diversity of opinion. The North-East Coast Institution of Engineers and

[1] *Nature*, Sept. 5, 1901, p. 463.

[2] If *evening* classes are objected to, a couple of afternoons a week would serve the same purpose in preserving continuity.

Shipbuilders, for example, recognises the following four alternatives [1]:—

Works -	12 months.	Works -	12 months.
College -	9 "	College -	9 "
Works -	15 "	Works -	15 "
College -	9 "	College -	21 "
Works -	15 "	Works -	15 "
College -	9 "		
Works -	3 "		
	72 months.		72 months.

College -	9 months	College -	9 months.
Works -	15 "	Works -	15 "
College -	9 "	College -	21 "
Works -	15 "	Works -	27 "
College -	9 "		
Works -	15 "		
	72 months.		72 months.

The representatives of the University Colleges and Technical Schools who attended the Engineering Conference (with the exception of Professor Burstall, of Birmingham) expressed their willingness to fall in with any scheme upon which the employers could agree. It is possible that they were so delighted to see some evidence of interest in Technical Education, that they were ready to clutch at the proverbial straw. And so long as the periods in Works and College are some multiple of half years, the College can probably adapt its

[1] *Technics*, Feb, 19 4, p. 195.

courses without much difficulty; but there must be uniformity of plan.

Even if the Sandwich system does become general, it will not altogether obviate the necessity for evening instruction which is to culminate in a full-time day course. Several members of the Conference—notably Mr. Yarrow and Mr. Dugald Drummond—emphasised the needs of the artisan's son, and the North-East Coast Institution's scheme recognises promotion from the status of apprentice to that of pupil. Years ago Huxley said: "Human life is such a sum that your opportunity multiplied by your capacity and divided by your circumstances, gives you the fourth term in the proportion—which is your deserts—with great accuracy"; and it is a healthy sign of the times that the necessity for eliminating all accidental elevation of the denominator should be so generously acknowledged. Everyone can demand the higher training if he can afford to pay for it, but the inalienable right of special aptitude must not be denied. And every year the spread of educational facilities is breaking down the barriers that once enclosed the privileged professions.

It does not follow that the Sandwich system must start immediately on leaving school. A period in the works may precede it; and at the Conference Professor Barr read several letters from Scotch Engineers in which, while it was generally conceded that the Sandwich system had much to recommend it, one or two years in the shops were preferred before going to College. The proposals of the L. and S.-W. Railway Company (p. 174), of Mr. Yarrow (p. 174), and of the North-East Coast Institution of Engineers and Shipbuilders (p. 167), contemplate

the admission of apprentices direct from school, with a Sandwich course in the last two years of apprenticeship. It may also be noted in passing that the Mechanical Engineering and Higher Mechanical Engineering Schools of Prussia require their students to have spent at least one year in the works before admission.[1]

The men engaged in the ordinary operations of Building will probably not require full-day courses of instruction. There has been, at any rate, no great demand for them in this country, though the Building Trades Schools of Germany have large numbers of day students, especially in the winter months. The usual method of starting a lad in one of the branches of the trade in this country is as an indentured apprentice, with or without a premium. Thus in London it is customary to charge from £25 to £100, while in South Wales it costs about £30 to article a boy to plumbing. The practice is not uniform, and in many cases no articles are signed. Under such circumstances the employer can easily get rid of an unsatisfactory apprentice, while the latter can, after a few years, go to another place as an improver. Apprenticeship seems to be on the wane in some districts. The special Sub-committee of the Technical Education Board of the London County Council, appointed in 1897 to inquire into the Building Trades, found only 80 apprentices and 143 learners, where the normal proportion would have been 1,600! The deficiency is stated to be so great among plasterers that many architects are looking about for substitutes

[1] Diplomatic and Consular Reports, Miscellaneous Series, No. 601.

for plaster. There are also difficulties in the brick-laying trade, because it is not customary for boys to work on the scaffold.

"The only alternative, therefore, apart from the present system of introducing provincial trade labour at the expense of the prospects of the London boy, is to train youths in the schools until they are sufficiently skilled to induce employers to take them on at a reasonable weekly wage, and without a premium. The recommendations contained in the report are as follows:—(1) That every effort be made to lengthen, with Parliamentary sanction, the present term of school life, including a raising of the legal age for leaving school, and that between thirteen and fifteen opportunity should be afforded for special instruction in manual training and drawing. (2) That no restriction whatever should be placed upon the persons attending theoretical classes in technical subjects, apart from the general requirements that the members of the class should be capable of profiting by the instruction afforded. (3) That with a view to enabling artisans to become qualified as general foremen, mechanics belonging to any branch of the building trades be permitted to attend both theoretical and practical classes in other branches of the building trades. (4) That learners under nineteen years of age and improvers should be permitted to attend practical classes, provided that they show sufficient familiarity with the trade to render their efficient training possible without undue interference with the progress of the class. (5) That in the teaching of the purely trade classes (evening), and in the examinations connected with them, stress should

be laid on methods which secure mechanical skill and quickness of workmanship, as well as on theoretical knowledge, and students should not be encouraged to expend an undue amount of time and labour upon elaborate models of no practical use. (6) That as far as possible the teachers should be actually engaged in the trade in which instruction is given by them. In order to secure this, special classes should be instituted to qualify competent mechanics to become teachers, and for this purpose the polytechnics should be used as centres of normal training."[1]

The only comment that need be passed upon the recommendations is, if the first is so important, why does the second exist?[2] It can only be accounted for by a desire to check at once the growing dearth of journeymen which must result from shortage of apprentices. At the same time, if the foremen are to be chosen from this class, no surrender on the question of a sound general education can be countenanced.

For the higher grades — Architects and Civil Engineers—College training is almost indispensable; but as in a large number of cases lads are articled direct from school, evening classes, or their equivalent in partial day courses of instruction, are of great value as affording suitable preparation. These two professions are highly exclusive, and heavy premiums are the rule.

In Coal Mining again, the usual practice is to admit lads direct from school, but there is no such

[1] *Building World*, March, 1899, Supplement, p. 4.

[2] "Capable of profiting by the instruction" is a vague phrase.

thing as an ordinary apprentice. The lads are, as a rule, mere labourers, and their treatment differs in no way from that of the colliers. Pupils are articled for a term of years, and pay a premium. Only a small proportion at present proceed to Technical Colleges, but the number should increase. The introduction of machinery, and the difficulties which will have to be faced ultimately in working the poorer seams, will call for men of wider scientific knowledge than obtains at present. Evening classes as a preparation for more advanced training have here again a wide field. It is noteworthy that students who propose to enter the Mining Department of the University of Birmingham are recommended to spend one year in actual practice before entering.

The Metallurgical and Chemical industries offer a sharp contrast between the two grades of men engaged. The division between the unskilled labourer and the chemist or manager is wide and deep. There are, at any rate in the districts with which the writer is acquainted, but few pupils, and lads are taken into the laboratory or works direct from school.

It will be evident, then, that in the industries which have been considered, a second function of the Evening School in relation to Technical Education must be acknowledged. There must be provision for instruction which, while preserving the general continuity of study, lays a broad and solid foundation upon which the higher studies of the Technical College or University can rest. And this must be given without imposing an insupportable burden upon young men who will be engaged for nine or

ten hours a day in the workshop, factory, or mine. The success with which this can be accomplished depends upon the care taken in arranging the curriculum. A necessary precursor is the due recognition of the Evening School as an essential element in the educational machinery of the country.

An additional function may be looked for in the case of larger institutions in the form of special instruction for men who are engaged in practice, and who have already had suitable preliminary training. While advanced instruction in evening classes is not to be generally recommended, the rapid progress of industry renders it desirable in many cases that it should be given. Such teaching would be of a highly specialised character, and would deal chiefly with recent progress in particular departments. It need not be given by a member of the regular staff of the school.

The Evening School, then, may provide instruction for three classes of students:

(1.) Those who obtain the whole of their training during the time they are engaged in earning a livelihood.

(2.) Those who will ultimately complete their training by attendance full or part time at a Technical College.

(3.) Those who have already been trained under (1) or (2), and who require special instruction of an advanced type.

Subsequent criticisms of and suggestions as to the character of the instruction will be based mainly upon three assumptions:

(1.) That in the four great industries considered,

the need for skilled craftsmen has decreased and is decreasing.

(2.) That, on the other hand, the need for intelligent supervision is becoming of more and more importance.

(3.) That in general the number of men undergoing instruction who possess the personal qualities necessary in those who are to exercise responsibility, is, as a rule, barely sufficient to fill vacancies in the ranks of officials.

CHAPTER II

THE CONTINUATION SCHOOL

In the previous chapter it has been remarked that Continuation Schools form the basis of the evening educational fabric. They have existed, with many vicissitudes, throughout the greater part of the last century, but apparently were not regularly in receipt of Government grants until 1855. By that year recognition was accorded to such schools as were held in connection with a day school, and aid was given in the form of capitation grants and payments to teachers. The amount paid in grants between 1859 and 1860 was only £2,196, so that the schools could have been neither large nor numerous. It is interesting to note, moreover, that until 1861 teachers in day schools were forbidden to teach in night schools also.

As a result of the reorganisation which followed the Education Act of 1870, persons between the ages of twelve and eighteen only were eligible for grant, but in 1876 the upper limit was raised to twenty-one. The average attendance fell from 73,375 in 1870 to 26,009 in 1886. The abolition of the strictly elementary character of the instruction given in these schools in 1890, and the publication of a suggestive code which greatly extended the scope of their operations in 1893, have led to an

enormous increase in the number and size of the schools; and in 1897 there were 358,268 students in 4,226 schools.

The number decreased a little some two or three years ago, but is now showing signs of considerable increase.

The object of such schools was at first to remedy the defects of elementary education, due either to the early age at which regular attendance at the elementary school ceased, or to the years of stagnation which frequently elapsed between leaving the day and joining the evening school. The growth of Evening Technical Classes has added the duty of preparing students for subsequent technical studies. The powers to extend their curricula, and to admit students over twenty-one years of age, which were given to these schools in 1890, have seldom been taken advantage of in the best possible way. Numerous instances arose in which overlapping occurred, and while cases of this sort are rapidly disappearing—and in many districts have almost entirely disappeared — the equally important function of providing a ground - work for technical education is only just beginning to be the subject of educational effort.

That the Continuation Schools have not fulfilled the expectations of those who promoted them is due to a combination of circumstances. The growth of large towns, increased facilities for locomotion, and better wages, have brought with them overcrowded dwellings, less comfort, and a more morbid craving for excitement, which tend to induce those anxious for a new experience to try what an Evening School

can do for them, without giving any inclination for serious study. So that, notwithstanding the enormous increase in numbers, it is doubtful whether the increase in efficiency is at all comparable with the development of the system. While recognising that there are many cases of individual effort which lead to good work, it cannot be seriously admitted that, looked at as a whole, the Continuation School is performing its part in the educational machine. And without prejudice to such efforts, it may be useful to state some of its difficulties and shortcomings.

The fundamental problem is that of irregular attendance. The average attendance in Continuation Schools during the last few years has varied very little. The percentage of those who had been under instruction during year 1902-3, who had made a sufficient number of attendances to secure the grant, was 60·5 in regard to boys and men, and 63 in regard to girls and women, giving an average of 61·5. The condition for earning this grant was that the student should have received fourteen hours' instruction during the session in each subject for which grant was claimed. In a large number of cases reading, writing, and arithmetic were taught in combination, and a very short period of instruction would then be necessary to qualify. The actual proportion in average attendance was therefore in all probability well below 60. Even if this reached 50 per cent., the case is bad enough, and this estimate is probably too high. For how can any school carry on its work efficiently when half of its students are constantly absent?

The matter is still worse when looked at more

closely. In those districts in which the schools are conducted in a somewhat casual manner—and such districts do exist—students are admitted at any time during the session, and the average therefore represents, not a constant quantity, but a shifting body of pupils. Moreover, this entails a change of teachers. The number on the staff is usually at the rate of one for every twenty-five students in average attendance. A teacher may start the session with a class of fairly even attainment; after a few weeks the numbers in the school fall, and the services of one of his colleagues is dispensed with; he then finds himself in charge of a class of mixed standard, half of whom have to get used to him and he to them. The wonder is that under these circumstances educational work can be done at all.

Various methods which have been tried to secure more regular attendance have met with little or no success. Returning the whole or part of the fee; annual outings, or social evenings during the session; lantern entertainments and concerts; making the schools absolutely free—are experiments which have only been successful in isolated instances. The lack of any real liking for study, of any real desire to learn on the part of some students, and counter attractions, have proved too strong. And only in schools where the personality of the teacher is able to make itself felt does the attendance represent a reasonable proportion of those on the register.

A certain proportion of the students must always be absent on account of their employment. Overtime and night-shifts are inimical to all evening

work, but not to such an extent as would make the attendance harmfully unsatisfactory. The real cause is the student who only comes for shelter, or to pass time, and upon him must be laid the blame for that lack of efficiency which can be attributed to irregular attendance.

It is open to question whether such a student should be permitted to interfere with the progress of the 40 or 50 per cent. who join the school with a serious purpose. If students who failed to attend on two successive evenings were refused admission the next time they presented themselves, unless they could furnish satisfactory explanations, the difficulty would probably, at any rate in part, be overcome. For though a student may not mind paying 2s. or 2s. 6d. for the privilege of obtaining shelter and warmth when required, he would find the new arrangement rather expensive. While this would not affect the student who attends regularly for six or eight weeks and then leaves, there is still a way of dealing with him. He could be refused admission in a subsequent session unless he deposited double fees as a security for his good behaviour.

There is some tendency to regard Continuation Schools as meeting a social want, and to lay less stress on the more strictly educational value of their work. Apart from the fact that the propriety of applying public money to such a purpose is open to question, this sentiment may lead to undesirable results, and its prevalence in many cases not only renders the schools unable to carry out one of their important functions—that of supplying preparatory training for technical students—but leads to much

misconception as to the value of the work which such schools can accomplish when intelligently conducted.

The evil of irregular attendance, and the difficulty of coping with it under a voluntary system, is leading many people to look to compulsory Continuation Schools as the only solution of the problem. The idea, like many others which tend to systematise instruction, was adopted, if not "Made in Germany." For example, in Saxony Continuation Schools are compulsory up to eighteen years of age. These schools originated many years ago in the Sunday Schools, because it was found that pupils of the latter institution were so deficient in general education as to be unable to follow the religious instruction. The first step was the addition of secular subjects to the Sunday School curriculum, and these were afterwards increased, so that one or more evenings were occupied, in addition to Sunday. While the age to which compulsion extends is fixed for the kingdom, the amount of instruction is controlled by the locality, and varies from two to eight hours a week. The first subject taken is the Mother Tongue, and Arithmetic and Drawing are added so far as time permits. In some of the towns the natural disadvantages of evening work are avoided by the enlightened attitude of employers of labour, who liberate their apprentices on certain afternoons during the week for the purpose of attending the school. This permits of apprentices in the same or in similar trades being taught together, and has an important effect in enabling the instruction to assume a technical character.

Differences of national temperament cause hesitation

in transplanting any system, and while the system of Saxony may be admirably adapted to Saxony, it cannot be assumed that it would be equally successful in this country. There is a rooted objection to all legislation which circumscribes the action of an individual, even though he be a child in his early teens. But in spite of such objections, it appears practically certain that the failure of all ordinary methods to secure regular attendance will necessitate State interference as the only remedy.

But the change, while revolutionary in effect, would have to be evolutionary in method. Before public opinion could be brought round to view the innovation kindly, it would be necessary to demonstrate the feasibility in particular cases. And this would have to be done by a body with statutory powers to experiment in this direction. At present the compulsory powers of local education authorities apply only to the day school. If these could be extended at the option of the authority to Continuation Schools, and that too at a time when interest in educational problems is keen, some novel and far-reaching experiments might be expected. An authority that decided to enforce such powers might be conceived to reason as follows:

"We provide instruction in the elementary day school for children up to fifteen years of age. But in order that individual hardship may not be imposed in cases where the earnings of the child are essential to the support of the family, parents may remove their children at (say) thirteen years of age, provided that the attendance up to that time has been satisfactory. Such children, however, will be

required to attend on three evenings a week in the six winter months during two years, for each year of absence from the day school below fifteen."

A Bill containing similar proposals, with modifications for agricultural districts, was introduced into the House of Lords in August, 1904, by the Bishop of Hereford; and the idea of compulsion is strongly advocated by Mr. Michael Sadler in his "Report on Secondary Education in Liverpool." The plan proposed would not be so prohibitive in cost as one which made attendance compulsory up to seventeen or eighteen years of age, irrespective of length of time in the day school. It must be borne in mind that existing schools could accommodate on the average twice as many pupils as there are at present attending them, without anything like a corresponding increase in cost. And with an average attendance of even 75 per cent., the educational possibilities would be enormously increased. The scheme would provide another method of securing satisfactory elementary education for those local authorities who fear to raise the standard of exemption on account of the individual hardships that might result from such action. People who contemplate education from the comfortable seclusion of the study may not realise the existence of such hardships, but it may be asserted after the manner of Galileo that nevertheless they do exist, and that in many districts cases of hardship are neither few nor far between. It may be argued that to permit the child to begin to earn wages does not guarantee that he will be better clothed and fed, and possibly in some cases he may not. At the same time, the

greater number of ill-clad and ill-fed children come from homes in which the poverty is due quite as much to lack of money as to lack of wisdom in spending it. And a well-fed child attending three evenings a week during the winter months is better educational material than a half-starved child attending full time throughout the year. His attendance at school at a time which does not detract from his capacity for earning wages would be more regular, and the prolongation of the mental and moral discipline of the school over the period of adolescence would be beneficial to the individual, and in the aggregate a national gain.

While many of the criticisms levelled at Continuation Schools are directed towards evils which, in the present state of the attendance, are unavoidable, the differences in the results attained in individual schools show that other defects exist.

In no other educational institution does the personality of the teacher stand for so much. In many instances the happy selection of a teacher may be assigned as the reason for the excellence of the work done. There is no doubt that in a very large number of cases the headmaster of the day school has an influence over his old boys that an assistant cannot possess, and some of the best work in the country has been done in schools in which such a man has been appointed principal teacher of the evening school. But whilst it is all-important that the head teacher of an evening school should be a man of experience and commanding personality, whose authority and influence shall permeate through staff and students, various causes have led to the

appointment of men who have not yet attained these qualifications.

In the first place, the headmaster of the day school, if it is a large one, may already be fully employed, or he may have other pursuits which prevent his undertaking work in the evening.

Then, again, assistant teachers generally receive salaries which are barely adequate for their existence, and many authorities have considered themselves justified in dividing the salaries for evening work amongst their assistants to make their total emoluments more nearly approach the "living wage." And by degrees in some districts the evening school work has come to be looked upon as the perquisite of the assistant, regardless of his capacity for performing such duties.

But a strong protest must be raised against any such system, and in the interest of the education confided to their care, authorities must be urged to appoint a head teacher who is equal to the responsibilities that he will have to bear, and to furnish him with assistants qualified for the work they will have to do; and in neither one case nor the other should these be men already jaded by a hard day's work, and undertaking an ungrateful task to enable them to eke out a scanty salary.

It has been noted on page 31 that educational difficulties have arisen through the somewhat rigid application of a "staffing" rule. A characteristic feature of Continuation Schools is the range of attainment exhibited by the students. In few cases are less than three grades found, and if the students are to be properly classified on admission, the "rule"

should allow a sufficient number of teachers to provide one for each grade of student until three or four stages of progress have been provided for. As other students join, they can be drafted into one or other of the classes already formed, and the only factor to be considered then is the maximum number to be allowed in a class. Thus, if one teacher were allowed for the first fifteen students in average attendance, two teachers for the first twenty-five, and three teachers for the first thirty-five, the addition of a teacher for every thirty-five or forty addional students would obviate the danger of under-staffing. An immediate increase in the efficiency of small schools, with sixty or seventy in average attendance, would result, while large schools would be unaffected by the change.

In the old days, when Reading, Writing, and Arithmetic were the only subjects in the curriculum of Continuation Schools, each student joining the schools followed the same course. Even now, the more elementary students who require instruction in the rudiments, follow a course of study which only gives rise to one regret: that it should be so terribly elementary. The great majority of children who leave the day school annually never come to the Continuation School at all, and those who do, allow several years to elapse before doing so.

This break in study is disastrous, and is intensified by the early age at which many still begin to earn a livelihood. The result is most felt in the case of Arithmetic. In the Elementary School simple fractions are introduced in Standard V., decimals in Standard VI., averages and percentages in Standard VII.

According to the Report of the Board of Education for 1902-3, Appendix A., out of 318 cases in which an alteration of the bye-laws was sanctioned, 227 authorities still recognised Standard V. as conferring total exemption.

A few years of absence from school is quite sufficient to provide teachers with pupils to whom a problem in proportion is a veritable Chinese puzzle; vulgar fractions have to be done all over again, and decimals imply a standard of knowledge beyond the wildest dreams of expectation!

To many, writing is a matter of no small difficulty; moderate accuracy in spelling is hardly even looked for; while poverty of vocabulary makes correct explanation laborious, and clear notions well-nigh impossible. Couple this with the difficulties due to bad attendance, and to providing for the variable capacity and attainments of the students who present themselves, and instead of criticising the want of progress and low standard, we must admire the patience and devotion of the teacher who effects even so small a measure of useful educational work.

But while the instruction in rudimentary subjects is of an elementary character, it must be admitted that it is generally suited to the requirements and capacity of the students, and that within the limits imposed by various disadvantages, they follow a sound and systematic course of study which cannot fail to be of considerable use to them. This is a favourable verdict which could not so generally be passed upon those subjects which, during the past twelve or fourteen years, have been gradually added to the Continuation School curriculum.

It is remarkable that with the introduction of subjects falling under the heads of Science, Technology, Commerce, and Languages, the idea of a curriculum to a considerable extent disappeared, and a system sprang up in which the student had almost absolute freedom of choice of subjects.

According to the Board of Education, General Reports on Higher Education for 1902, 324,709 students qualified for the grant. Of these,

147,594	took	one subject.
82,089	„	two subjects.
59,909	„	three „
35,117	„	four „

The first number probably comprises all those who took Reading, Writing, and Arithmetic as a combined subject.

The tendency, then, has been for the Continuation School curriculum to lose some of the essential unity which characterised it in the first instance in the attempt to cater for those who had attended the day school longer, or who had retained more of what they had learnt.

This unfortunate result is due to some extent to the failure of managers to understand and carry out the responsibilities they have undertaken, and to the many cases in which the head teacher neglected to exercise his prerogative to advise students and guide the course of study. The responsibility for the selection of subjects has been left to the students or the accidental presence of a teacher

with a knowledge of a certain subject. Sometimes, indeed, managers have so far exercised their function to select subjects which promised to be popular; but the net result has been an aggregation of classes under independent teachers with independent aims, and each making its appeal to individual students. Unsuitable subjects have been introduced, and students left to choose without sufficient guidance have selected subjects not suited to their needs, and have failed to reap the educational advantages they might expect from the studies they have undertaken.

The introduction of unsuitable subjects, apart from its effect upon the work of the schools themselves, has prevented them from fulfilling their important functions as preparatory centres for the Technical School. One example which is fairly typical may be quoted[1]—the name is suppressed: "At the last competition for evening scholarships in the —— Technical School, 166 of the candidates (who must be over fifteen) had attended evening schools; of these only 21 had studied Arithmetic, yet 38 had been attempting to learn Machine Drawing."

While the defects in this particular example have probably been now removed, the progress towards a fuller recognition of the importance of sound educational work goes on slowly. Most large towns have issued regulations for Evening Continuation Schools in which students are strongly advised to undergo a "course" of instruction, and to consult the headmaster as to what this should consist of.

[1] Board of Education Reports on Science and Art Schools and Classes and Evening Schools, etc., for the year 1901.

At the same time, the tendency to *prescribe* "courses" is only gradually increasing, and if a student is willing to pay the full sessional fee, and to devote himself to a single subject, there are few cases in which he may not do so. In this connection, however, there is to be discerned considerable activity, and the next few years will see a pruning and shaping of the curriculum that will enable Continuation Schools to fulfil their function in a complete and satisfactory manner.

But after all, the extent to which such schools can become efficient members of the educational system of the country depends upon a solution of the problem of regular attendance. If a compulsory scheme is too far off to look for with confidence, there seems nothing for it but to await a more enlightened state of public opinion which shall result in parents exercising more control over the educational welfare of their children. Employers of labour can, and sometimes do, bring pressure to bear. For example, Messrs. Brunner, Mond & Company, at Northwich, who have a monopoly of labour in that district, refuse to employ any boy in their works under fourteen years of age, so there is no incentive to leave school earlier. They stipulate, moreover, that when employed he shall attend an Evening School for three nights a week until he is seventeen.[1] There are other employers who would be glad to adopt such a course if they could induce those in the same

[1] Board of Education Reports on Science and Art Schools and Classes and Evening Schools for 1901. The age was raised to nineteen in 1903: see Article on "Evening Continuation Schools" in *School*, June, 1904.

district to co-operate with them. Meantime, there appears to be no reason to hope that "popularising" the curriculum would lead to any permanent improvement, and it seems more desirable to recognise the claims of the 40 per cent. or so of students who are really anxious for instruction, and who possess the necessary stamina to submit to an educational course, than to do anything to help those who merely use the school as a convenience.

Disregarding, therefore, the recreative element in Continuation Schools, and concentrating attention on their more strictly educational function, it may be useful to inquire into the most suitable curriculum to secure effective co-ordination with that of the Evening Technical School. Before considering the subjects in detail, however, one or two examples will be given to illustrate the types of curricula now being followed.

The Continuation Schools at Swindon have different groups of subjects for men and boys. The former study Reading, Writing, Arithmetic, and Elementary Science; the latter Reading, Writing, Arithmetic, and Drawing, with Citizenship apparently as an optional subject. The separation of men and boys does not appear to be so common as it was some years ago.

Bristol provides three grades of schools: Primary, which are confined to the work of the day school standards; Commercial, for admission to which students must have reached Standard VI.; and Higher Grade and Elementary Science Schools, in which the same standard of admission obtains. The word "grade" is hardly applicable here; "type"

would be more accurate. There are seventeen schools of the first type, six of the second, and three of the third.

A more elaborate scheme is in operation at Bradford. This includes three grades, viz:

I. Evening Continuation Schools.
II. Schools for Artisan and Commercial subjects.
III. Higher Evening Schools.

The first group are stated, in effect, to be continuative and preparatory, though it would conduce to clearness if a sharp distinction were made between these terms. The subjects are, generally speaking, those of the upper standards of the Elementary School. Specialisation is commenced in the second grade. The student is here strongly advised to attend a "course" of study, and he is informed that the selected subjects should bear upon his probable future occupation. The group of subjects suggested for artisans is as follows:—

First Year.	Second Year.
English.	Freehand.
Practical Mathematics.	Practical Mathematics.
Technical Drawing.	Technical Drawing.
Woodwork.	Wood or Metal Work.

Higher Evening Schools are intended to lead up

to the work of the Technical College, and the table below gives a proposed two-year course:

First Year.	Second Year.
Practical Mathematics. Technical Drawing. Physics. Machine Drawing, or Building Construction, or Freehand.	Practical Mathematics. Practical, Plane, and Solid Geometry. Physics (Heat, or Magnetism & Electricity). Machine Drawing, or Building Construction, or Chemistry.

Of the 46 schools, 36 are of Type I., 11 of Type II., and 3 of Type III. It may be noted in passing that the curriculum of the Type III. schools approximates to that of a Technical School in that definitely technical subjects, such as Machine Drawing and Building Construction, are introduced. There is evidence, however, in the subjects of examination for scholarships given below, that students who have the capacity for proceeding to higher schools are not encouraged to study technical subjects at this stage.

For Admission to Type II. Schools.

English.	Arithmetic.
Geography and History.	Freehand.

For Admission to Type III. Schools.[1]

English.	Practical Mathematics.
Technical Drawing.	Freehand.

For Technical Scholarships.

English.	Physics.
Practical Mathematics.	Freehand (optional).
Technical Drawing.	

The scholarships are awarded on the results of an examination held in March, and students must have made not less than 80 per cent. of the possible number of attendances. The course selected by a student must be determined by his present or intended occupation, and Home Lessons are compulsory. Half the travelling expenses are paid to scholarship students residing beyond a penny tram stage from the school at which a scholarship is tenable, provided that the student make not less than 80 per cent. of the possible attendances.

As a further stimulus to regular attendance, a bronze medal is awarded to each student who makes perfect attendance in the first session, a similar medal for perfect attendance in the second session and a silver medal under the same conditions in the third session. Moreover, the full fee is returned to those who make not less than 90 per cent. of the possible number of attendances, and half the fee to those who make not less than 80 per cent. As, however, the fee is only 2s. 6d. per session, or 3d. per week, in Types I. and II. Schools, and 5s. per session in Type III. Schools, it is somewhat doubtful

[1] Artisan course only.

whether the return of half or the whole of the amount is a very powerful factor in encouraging regular attendance. And in any case, the propriety of returning this as money, rather than in the form of prizes, may be a matter worthy of consideration.

The desirability of close connection between the Elementary Day School and the Continuation School is also being kept in view. Scholars who, leaving the Day School during the session, join a Continuation School at once, are eligible for medals and the return of fees under the conditions stated above, the attendance being calculated from the date of leaving the Day School.

The Bristol and Bradford schemes are fairly typical of the tendencies in large towns, and the underlying idea of gradation, with the elements of specialisation in schools of the higher type, may be regarded as an arrangement which will spread in time to smaller centres of population. In this connection it may be noted that there are in the country many thickly populated areas[1] which while consisting of separate small towns or large villages, bear some similarity in regard to population and means of communication to large towns. The needs of such districts could be most satisfactorily met by an organisation of the kind that has been described. For though each constituent town or village could not always be expected to provide a sufficient number of students to carry on a higher type of school with economy and efficiency, students could be drafted to such schools established in the larger centres.

[1] *E.g.*, on the Coalfields.

The Bradford system provides for three grades of school below the Technical College, and the Bristol scheme for two.[1] In order to simplify nomenclature, it will be assumed in what follows that it is sufficient to recognise two types only of Continuation Schools. It will be convenient to call the lower grade "Continuation Schools," and the upper grade "Preparatory Schools."

The curriculum of the Continuation Schools will be mainly Reading, Writing and Composition, and Arithmetic. As to the particular nature of the first subject, one meets with considerable differences of opinion. On the one hand, it is argued that in order to interest students in their daily occupation, and to encourage them to attend the school by giving the instruction a practical bearing, the reading-book should have direct reference to the industries of the locality.

On the other hand, it is maintained that no opportunity should be lost to give the student information as to his civic duties and responsibilities. As against the first view, it is urged that there are many industries for which no suitable books have been written—or, at any rate, such books have not been published at such a low price as to render their introduction into Evening Schools possible. This is not so with Life and Duties of a Citizen. Really good instruction in the latter subject, however, requires a teacher of exceptional abilities and sound judgment, and pupils who are old enough to appreciate the

[1] Schools having the same standard of admission may be regarded as of the same grade.

problems considered. It is important to bear in mind that a teacher will handle that subject best in which he feels most interest, and as in no other subject is the teacher's own individuality of such paramount importance, this points to the necessity not only of carefully choosing the teacher, but also of giving him considerable latitude. Many useful lessons directed towards both of the objects mentioned above can be drawn from History, Geography, Biography, and Travel; and it should not be a difficult matter to arrange a course of reading which shall more or less satisfactorily combine the good points of each.

Fiction has not been mentioned here because most people read seriously, and can be got to read seriously, for information rather than for pleasure. There is little to be gained by pressing the view that study should be carried out for the love of study, and much by recognising that in nearly all evening education we are dealing with an incentive—sordid if you will —which arises from necessity. If the student can be shown that there is in books a great deal that is of real service to him, and if he can be taught how to use books to obtain information, he will have been assisted to mount the first step in the ladder of self-improvement.[1] He might be shown, for example, how

[1] No one can teach in evening technical classes without being impressed with the difficulty that the elementary schoolboy finds in private study. He has been accustomed to skilful oral instruction, necessitated by the fact that all the study must be done under the teacher's supervision; he has rarely, if ever, attempted home work; and the transition to the methods of the higher institution in which he will have to depend to a greater extent on his own resources renders it most desirable that an attempt should be made to reduce the abruptness of the change.

to obtain statistics from one or other of the cheap year-books that are now issued; and these could be plotted on squared paper during the lesson in Arithmetic. An opportunity is thereby offered for correlation, which is so important a factor in intelligent progress.

Reading also provides material for exercises in Writing and Composition. Much of this should be done at home. The presence of the teacher and the limited time of the lesson are often hindrances rather than aids. If, as happens in some districts, the students come from homes which present few facilities for study, one of the rooms in the school might be thrown open on one evening in the week for private study. The presence of a teacher might be necessary, but the expense would be well repaid by the greater rate of progress.[1]

In Arithmetic there is room for a more widespread use of the new methods. Of all students, those in Continuation Schools have the least time to waste, and in their case the exclusion of unnecessary detail, and the inclusion of rapid and approximate methods of calculation, are of the greatest importance. As it will probably not be possible to group students according to occupation, not much can be done in regard to so-called workshop calculations. Concrete examples will be used in preference to mere juggling with numbers, but if the students are young, or at all mixed, the introduction of trade examples at this stage should be undertaken with caution.

[1] A plan of this sort, worked in connection with the upper classes in Elementary Schools, might be very useful in encouraging habits of private study; or one afternoon a week might be utilised for the purpose.

So far nothing has been said about Drawing. The ability to make freehand sketches and to perform simple geometrical constructions is of such importance to those who will subsequently become technical students, that it ought to be included. In a school which meets three nights a week for two hours a night, it should be possible to make fair progress with two 40-minute periods a week in Reading, two in Writing and Composition, three in Arithmetic, and two in Drawing.

The leading idea in the foregoing observations is that the function of the Continuation School is first to remedy deficiencies in *general* education. It is not technical, because the students are generally too young, and in any case, are too ill-equipped to commence specialised study. And for the same reason it is not even preparatory. The aim should be to raise the student to the level of the average Seventh Standard boy in the essential subjects of elementary education. Some exception may be taken to the fact that Manual Training has been ignored. But as Herbert Spencer says, it is the *relative* and not the *absolute* value of subjects that concerns us. The point of view has been that the students are the minority who both wish to learn and have the stamina necessary for success; and it has been assumed that a fair proportion will proceed to a further course of study in schools of a more advanced type. At the same time, there is no intention of asserting that Manual Training would be out of place, and it might be found desirable to introduce it instead of three lessons—one in each subject—when the level of the Sixth Standard had been reached.

The curriculum of the preparatory section has next to be considered. The standard of admission has been indicated above, and the students would be lads of fourteen or fifteen fresh from the Seventh Standard of the Elementary School; youths who had passed through the Continuation School curriculum; or young men whose absence from school had not resulted in a fall in attainment below that specified. They will be prepared to take a first step in specialisation, but how far this step is to go is a matter which cannot be subjected to any hard-and-fast rule. Much depends on the extent to which a majority of the students will be able to proceed to higher work, and this will depend very largely on the proportion of men actually engaged in the industry who desire instruction, in comparison with the relation of the number of officials (foremen, etc.) to workmen.

In order to illustrate the latter point, an example will be worked out, and for this purpose Coal Mining will be selected. In a certain well-defined area there are 30,000 men engaged in the industry, and about 250 undergoing instruction in the Principles of Mining. Of these, there are not more than about 150 in average attendance. If it is assumed that the average time spent in these classes is two years, then $\frac{1}{4}$ per cent. of the men engaged in the industry are turned out of the classes annually.

The proportion of officials to men in Coal Mining is about 1 to 80. The average life of an official may be estimated roughly as 20 years. The number of vacancies occurring annually among officials is equal to $\frac{1}{1600}$ of the total number of men engaged. The ratio, therefore, of the number of students turned

out annually to the number of vacancies among officials is 4 to 1. Some of these students have only had a year's training, and not all of them possess the personal qualities which are required in one who has to exercise authority.

The conclusion to be drawn from these figures is that the number of students attending the Mining Classes in this district is only just sufficient to supply the demand for trained officials. Reasons will be given later for the opinion that the colliery manager requires the training of an Engineer, so that if the way for advancement is to be left open, the provision of a broad basis of general education and scientific knowledge is a matter of some consequence. The curriculum of the Preparatory Technical School should attempt to supply this.

There are other industries in which the proportion of students undergoing instruction is much higher than in the case of Mining. In some towns the number of Engineering students in the classes is 4 per cent., and in the case of Machine Drawing Classes in colliery districts it is not uncommon to find 30 or 40 per cent. of the mechanics in attendance. Again, in the Building trades a good teacher of Building Construction may have a large proportion in his class.

It is considerations of this kind that must determine the character of the curriculum at this stage of evening school education. If the number under instruction is very much larger than will serve to keep up the supply of trained men, then a more elementary scheme of studies with a strong technical element is required. And if the number

under instruction is more nearly in agreement with the demand for trained men, a more liberal and scientific scheme should be provided.

It is difficult, however, to draw a sharp line, and to say to one—"You are to remain a workman for the rest of your life," and to another,—"You are destined to exercise power and dominion over your fellows." So long as the student is under twenty, it would be rash to predict, from a knowledge of his abilities in the lower grade, his subsequent success in more specifically technical work. If the number of students warrants the establishment of two courses of instruction, what then is to determine who is to attend each? The choice can hardly be left to the student, who at this stage is rarely imbued with the necessity for a sound basis of general and scientific education. Experience has shown that the title of the "Trade" subject exercises a fascination that cannot be disregarded.

The solution of this problem appears so difficult that it might be more advisable to adopt one curriculum as a compromise. The privilege of choosing could then be offered later on, and if the excess of the annual technical school product over the annual demand for officials was not very large, this would probably be the most satisfactory plan. But in the face of the number of indeterminate factors which enter into the question, the remarks on the curriculum which follow must be regarded as going no further than suggestion.

The points to be kept in view in drawing up a preparatory course of study for technical students may be shortly stated:—

(1.) As the student is only at the commencement of his employment in the workshop, the factory, or the mine, he will not have a sufficient knowledge of the trade to fully appreciate technical teaching.

(2.) Since he presumably possesses no knowledge of Physical Science, which, from its numerous applications in industry, is essential to a correct understanding of industrial processes, a study of those branches at least which find most frequent application should be included in the curriculum.

(3.) Since but little progress can be made in technical subjects without some training in Mathematics and Drawing, these subjects are essential. The Drawing is understood to include sketching and geometry.

The essential subjects, therefore, are Mathematics and Drawing, Physics and Chemistry, and it will be of interest to inquire into the standard. Boys who enter industrial life come from three sources: elementary schools; secondary schools, which lose the majority of their pupils at sixteen; and larger secondary schools, with a more extended curriculum. The first class is now under consideration, and it seems reasonable to suggest that the preparatory course should endeavour to attain the same level as the average boy from the second type of school in those subjects which are of most direct value in subsequent technical studies. This view finds support in the fact that large numbers of boys from the second type of secondary school enter, *e.g.*, the engineering industry, and it is found that lads with the amount of scientific and mathematical knowledge which even two or three years' attendance at such a

school enables them to obtain, make good progress in science and technical classes. The Physical Science will include the elements of Mechanics, Heat, and Chemistry. As the students will in general be older than those in secondary schools, and will have the use of books, there should be no difficulty in getting over the ground in two years. Should a laboratory be available, one lesson a week will be all that can be allowed; but if practical work is not possible, two lessons a week would be appropriate.

Mathematics and Geometry would cover another two-lesson periods, and this provides work for two full evenings. The third evening could be devoted to Sketching and Reading. This last is the only subject in which it is possible to lift the student out of the street and the epoch in which he lives; it is the only, or, at any rate, in the hands of a skilful and sympathetic teacher, the best subject through which his mental horizon may be widened and his imagination stimulated. All the others, useful in their way, have yet the narrower object of explaining the events and phenomena of daily life and work. As this is the stage of transition between general and technical education, between the period during which educational ideals may be mainly sought and that at which practical ideals begin to exert influence, it seems desirable to include at least one subject which is neither technical nor, in the narrower sense, scientific. And it is doubtful whether any other could be found to play this part. What has been said in regard to Reading in the Continuation School applies with equal emphasis here. Through this

subject, indefinite though it may be, the pupil may obtain his first introduction to the Public Library, and form habits of self-improvement that no vicissitudes of fortune are able to eradicate.

So far nothing has been said of Composition. It is assumed, however, that practice in this subject will be obtained incidentally in the working of home exercises; and it is a matter for regret that such an excellent opportunity is often allowed to pass by.

Certain objections to the above scheme which present themselves may now be considered. While a large number of Secondary School boys enter engineering works, the number who select the Building trades or Mining is comparatively small—probably not more than a small fraction of 1 per cent. It may therefore be questioned whether the argument from the Secondary School standard is fair in regard to those industries in which the men who occupy the higher positions have received much more thorough general education than that to which the majority of evening students can lay claim. Against this it may be urged that provision should be made for the student of exceptional ability to advance to any stage his powers may carry him; and the standard laid down represents the least upon which successful work in a Major Course of Technical Training (Chapter VIII.) could be assured.[1] Moreover, schools offering this course in any given area

[1] It is not at all certain that a lavish provision of scholarships from Elementary to Secondary Schools will effect a complete separation of brighter children from those of less ability. Natural aptitude may lie dormant for a time, until roused into activity by stress of circumstances or a sympathetic response to environment.

would be comparatively few in number, and the pupils would be the concentrated intelligence from six, eight, or ten schools of the more elementary type. If schools of the lower grade passed no more than 15 per cent. of their number, it would probably be sufficient if 5 per cent. followed the course under consideration. The remaining 10 per cent. could be dealt with in the following way:—

The plan would be to arrange a shorter or more elementary course which, while less ambitious than the one given, would still serve as an introduction to the Minor Courses described in Chapter VIII. This might include the subjects already mentioned, treated in 1-hour lessons in one year, or 40-minute for two years. In the first case, the second year work would be technical in character; in the second, technical subjects would be included in both years. A third course for workmen engaged in minor trades, or men whose prospective career makes a smaller demand upon general and scientific knowledge, could be arranged. Considered from the point of view of industrial organisation, the courses would belong to the training for managers, foremen, and workmen respectively. The latter is not strictly preparatory, but technical. It is only possible in cases where a large number of students engaged in one trade are in attendance. The relations between the schemes may be more clearly understood from the tabular forms given below.

The "trade" subject may be Preliminary Mining, Science of the Workshop (see p. 90), Carpentry, Brickwork and Masonry, etc.

I.—Major Preparatory Course.

First Year.	Second Year.
Practical Mathematics and Geometry. Reading and Technical Drawing. Experimental Mechanics (20 lessons) and Heat (6 lessons).	Practical Mathematics and Geometry. Reading and Technical Drawing. Heat (6 lessons) and Chemistry (20 lessons).

Note.—This scheme involves three nights a week, and gives time for Laboratory work in Physical Science. Technical Drawing includes sketching and drawing familiar objects to scale, and simple projection, while plane geometry is associated with Mathematics.

II.—Minor Preparatory Course, A.

First Year.	Second Year.
Technical Arithmetic and Geometry. Reading and Drawing. Elementary Science.	Technical Drawing. Manual Instruction. "Trade" Subject.

II.—Minor Preparatory Course, B.

First Year.	Second Year.
Technical Arithmetic and Geometry. Reading and Elementary Science. Manual Instruction or Trade Subject.	As in first year.

III.—Workmen's Course.

First Year.	Second Year.
Workshop Calculations. Technical Drawing. Trade Subject.	As in first year.

In every case it is most essential for educational progress that home-work should be done, and non-compliance with the rule should be as much a reason for exclusion from the benefits of the instruction as avoidable irregularity of attendance. Promotion from year to year ought to be on a broad and fair basis, and there is good ground for objection to the practice of making an examination the predominant factor. If any local examination is held, it should be

set on the teachers' syllabuses by independent examiners, and the questions should have the teachers' approval. The most satisfactory plan for determining promotion would take into account not only the ability to pass a test, but also habits of industry and punctuality which the student may have displayed during the year. A scheme which presents several advantages is as follows:

100 marks for maximum attendance.			
100	„	„	home exercises.
100	„	„	a first class at any examination that may be prescribed.
60	„	„	a second class at that examination.

This gives a maximum of 300 marks if the examination is counted, or 200 if there is no examination. It would be fair to fix the minimum for promotion in any case at 150.

Before closing this chapter, it may be desirable to state more clearly the conclusions which have been instrumental in determining the suggestions. They are:

(1.) That there is in Continuation Schools a minority of 40 per cent. who have serious aims and possess fair capacity.

(2.) That the interests of this 40 per cent. are, from the point of view of Technical Education, paramount.[1]

(3.) That since regularity of attendance is essential

[1] "Recreative" evening schools are outside the scope of the book.

for educational efficiency, this regularity must be secured at any cost.

(4.) That regularity of attendance may be attained in three ways: (i.) By offering encouragement in the form of scholarships, prizes, etc.; (ii.) by the influence of parents and employers; (iii.) by exercising severe measures—even to exclusion—in cases of irregularity.[1]

(5.) That although repressive measures might involve the closing of individual schools, the great bulk of Evening Technical Education (at any rate in the industries considered) is conducted in thickly populated urban areas which are served by a considerable number of schools, and it would be better to have five schools with an average attendance of 80 per cent. than ten schools with one of 40 per cent.

[1] To assume that this would kill evening work is to deny the existence of the nucleus of students who are in earnest.

CHAPTER III

THE DIFFICULTIES AND SHORTCOMINGS OF EVENING TECHNICAL CLASSES

A. Preliminary Training.

In the preceding chapter stress has been laid on the necessity for providing preliminary training for subsequent scientific and technical studies, and what was said as to the effect of a few years' absence from school upon those who have left at an early age applies with equal force here.

The difficulty of dealing with students who have only a limited vocabulary, who have forgotten how to draw, whose ability to write legibly and quickly has vanished, is best realised by those who have to teach in classes mainly composed of such students. As, moreover, explanations of processes require, even at the outset, some knowledge of Physical Science, as methods of solving problems require some knowledge of Mathematics or of Geometrical Construction, this knowledge should have been gained beforehand. So that if a fair standard of work is to be maintained in the Technical School, the standard of the Elementary School, even when freshly gained, is for many purposes insufficient.

Not only has the lack of preparation on the part of evening technical students been reiterated year after year by teachers, but the Reports of the

Examiners of the City and Guilds of London Institute, and of the Board of Education, have borne witness to the unpreparedness of candidates for examination. The supply of students from the Secondary Schools, established in great numbers during the past few years, has had its effect in diminishing the volume of complaint. So long as teachers could get a fair proportion of students able to follow the instruction, they have been more satisfied; the institution of a preliminary grade in certain City and Guilds subjects has deterred the weaker students from attempting these examinations; and the abolition of the influence of success in examinations in the elementary stage of subjects under the Board of Education, in determining the grant, has obviated the necessity of presenting students who had little chance of passing. But even if public attention has not been drawn so closely to the matter in recent years, there seems to be little need for congratulation. The standard of requirement continues to rise with the spread of knowledge and of facilities for obtaining it, and it is more than ever desirable that students should not only have had a better general education before joining technical classes, but that this should have included the elements of Physical Science.

However, there are considerable differences in the educational standard of the students in different localities. In the larger towns—especially those which are engineering centres—secondary education has been more rapidly and extensively developed than in smaller places, and in the neighbourhood of other industries. The engineering classes in such

places may have from 30 to 40 per cent. of their students who have been at least two years at a Secondary School.[1] Classes in Mining and Building Construction, on the other hand, contain a very small proportion of students of this type, and these are generally pupils articled to a Colliery Engineer or an Architect. In the case of Metallurgy, almost the only evening students are those engaged in assay offices and works' laboratories: these come, as a rule, from Secondary Schools.

Sound educational work is obviously impossible either where the standard of general education of the students is low, or where it is mixed, and indiscriminate admission to the classes is therefore responsible for placing the Evening Technical School at a considerable disadvantage as an educational institution. Opposition to schemes for regulating the admission of students arises from two causes: In the first place, there is the opinion which is unfortunately too prevalent, that if an institution can be filled, it is bound to do good work. To put it in other words, the popularity of an institution is regarded as a measure of its educational value. In the second place, there is a widespread unwillingness to exclude any student who desires to join the classes. So long as he pays the fee, he is not only admitted, but made welcome. Far from excluding students, all sorts of inducements have been held out to them,

[1] At Lincoln Municipal Technical School the proportion of students who have been at a Higher Elementary or Secondary School for two years is 36 per cent., and in a letter to the writer the headmaster expresses the opinion that in five years it will be 50 per cent.

whether this arose from the desire for numbers or in order to keep a moribund class alive. It cannot be too strongly emphasised that a full institution is often filled with mediocrity, and a pressed student is rarely a good student.

There is to be discerned, too, the underlying idea that Technical Education is intended to benefit individuals. It arises from the popular notion that it exists for the purpose of making a man a better workman. The view advanced in Chapter I., however, is quite different, and regards the matter as one of the essentials of industrial progress. The benefit is for the community. If the individual is suitably equipped for taking full advantage of the instruction, he may benefit personally, but quite incidentally.

The fact that Continuation Schools have in a number of cases hitherto been organised in complete independence of the Evening Technical School has probably had some effect in delaying the establishment of a standard of admission. The infirmities of the former institution were fully discussed in the preceding chapter, and there is little doubt that they gave rise to a certain amount of distrust—in many cases undeserved—which was felt both by those who controlled technical education, and by the students themselves. It has often been useless, as the writer knows from experience, to advise students to preface their technical studies by a period in the Continuation School. They would join the technical classes or nothing. The rapid and vigorous reorganisation of these schools which is now taking place, however, will enable them to win the respect of managers, technical

teachers, and students. The institution of a standard of admission to evening technical schools, examples of which will be noted in Chapter IV., will result in a distribution of the students over the two institutions in such a way as will enable both to carry out their true functions in the educational machinery of the country.

B. Variations in Age.

One of the most serious obstacles to the soundness of Evening Technical Education is the extreme variability in age. It is not at all uncommon to find students ranging from fourteen years or less to forty years or more in the same class. Such students differ much in their power of assimilating various subjects. The man who has spent years at his trade readily grasps practical details, but in his ability to sketch, in dexterity with mathematical instruments, and in his power of working numerical examples, he may be far inferior to his younger classmate. On the other hand, the immature mind and limited experience of the younger student render him quite unable to grasp the practical bearing of the teaching, the greater part of which fails to go home. The weaker members of both classes of students soon meet with difficulties that are too great for them, and the attendance falls in consequence.

Of those who remain, the man is generally the more serious, but makes slower progress owing to the long years during which his faculties have lain dormant. He is working with a purpose. Either he feels a higher position than that of a mere workman

to be within his grasp, or he may be already occupying a position of minor responsibility, and sees that one factor necessary for promotion is theoretical training. Against all his zeal he may have to pit the distracting cares of a family, the necessity of working overtime, and a hundred and one adverse circumstances from which the youth is free.

The difficulty of teaching a class composed of very young lads and much older men is very great. As a consequence of the different characteristics noted, the trade teacher often talks over the heads of the young ones; and the professional teacher, used to younger students, fails to get into touch with the older ones. This difficulty becomes more pronounced when a course of instruction (Chapter VIII.) is prescribed.

Extreme variation is met with in some classes to a much greater extent than in others. Mining classes contain a large proportion of older men; Building classes may or may not do so. Classes in Engineering subjects probably exhibit the greatest uniformity, but Machine Drawing in colliery districts is sometimes attended by students whose ages cover a wide range. It is interesting to note that the number of men over thirty who are attending the Municipal School of Technology, Manchester, is about 10 per cent. of the whole. At the Lincoln Municipal Technical School the percentage of students over twenty-one is 20. The percentage of students of both sexes over twenty-one in all evening classes throughout the country is 25.

There seems to be little doubt that the proper place for lads up to sixteen or seventeen years of age is the Continuation or Preparatory School. The nature of

the subjects and methods of teaching are alike more suitable to their age and experience. The loss in numbers to the technical classes proper could not be very considerable, as the proportion of students under fifteen is only 22 per cent. in all evening schools in the country, and it is probable that most of these are already attending the school of lower grade.[1]

Taking all things into consideration, it may be asserted, without much fear of contradiction, that the best work in Technical Education can only be done by those between the ages of sixteen and twenty-four. The older men are seriously handicapped by long years in which but little intellectual exercise has been indulged in, and their presence in considerable numbers in some districts adds to the difficulties which would meet any attempt to organise systematic curricula. They cannot be so easily persuaded that their standard of attainment is met by the continuation or preparatory course, and they would not be so ready to strive after that scientific knowledge which the increasing applications of science to industry render every year of more importance. The adoption of methods which led to the exclusion of a certain proportion of them from the classes would not reduce the demand for trained men, while the reorganisation of the system which seems likely to take place in the next few years would lead to a greater number of well-prepared younger men in their stead. No one desires to place difficulties in the way of those who desire to learn, but cases are bound to arise from time to time in which the interests of an individual or a group of

[1] Some individual classes would be very hard hit.

individuals have to be sacrificed in the interests of the community. This is one of the penalties of progress, and one which requires organising skill, foresight, and tact, if hardship is to be prevented.

C. *Irregularity of Attendance.*

While the average attendance in science and technical classes is not so low as in continuation schools, it is still a matter for serious consideration. In spite of the fact that the majority of the subjects taught have a bearing more or less direct upon the occupation of the students, anything over 70 per cent. must be considered good, and it is often much lower than this. A discussion of the question must distinguish between students who attend from time to time throughout the session, and those who attend regularly at first, and fall away completely from the end of the third or fourth week up to Christmas.

The first type of student may be one who has excellent capacity, but suffers from sheer laziness, and the best way to treat him is by excluding him from the classes if he can give no satisfactory explanation of his absence on two successive occasions. This course either drives him away from the class altogether, or stimulates him into activity. On the other hand—and this is more likely—the student is unable to attend regularly on account of his employment. Overtime and the night-shift are serious difficulties which present themselves in many districts, but they affect the older men to a greater extent than the younger ones. Examples of the attitude of the employers

described in Chapter VI. show that they are not unwilling, as a rule, to afford facilities for their workmen—especially for their apprentices—to attend evening classes; and this is the only way of dealing with this particular aspect of the problem.

The constant fall in attendance that takes place after the first few weeks may be attributed to any of the causes that tend to decrease the efficiency of the instruction. First and foremost must be put the personality of the teacher. The man who can keep a class of evening students together under existing conditions must be an exceptional man. He must know his subject, know his students, be familiar with the work upon which they are engaged. He must have some idea of the ultimate careers of the majority of his students, and a just appreciation of the function of his class in the school, and of the school in the industrial and educational machinery of the neighbourhood.

The second cause is the indiscriminate admission of students. Those who are inadequately prepared, or who are too young to follow the instruction, gradually fall off as fresh difficulties in the subject present themselves. In his efforts to keep such students in the class, the teacher sometimes neglects the more capable members, and this may lead to further loss.

A third cause, which is not dissimilar in its operation, is the lack of rational order and grouping of the subjects of instruction. If the logical arrangements which are possible are departed from, difficulties are introduced of exactly the same character as in the case of students whose

general education is deficient. This matter will be illustrated later.

The fourth cause is the want of direct relation between the instruction and the needs and capacity of the students, which forms the subject-matter of the next section.

The solution of the attendance problem is a joint matter. The education authorities must exercise care in the selection of teachers, institute a standard of admission, organise their curricula; and they must look to the employers not only to remove disabilities, but also to give encouragement to theoretical knowledge, and to the habits of punctuality and diligence which the school regulations will be framed to secure.

D. Connection between Classes and the Special Requirements of Students.

An objection is sometimes urged against evening technical instruction on the ground that it has not a sufficiently direct bearing on the occupations of the students. The latter naturally desire to learn what is of immediate benefit to them, and if the first few lessons do not seem to have any relation to their daily work, they are discouraged. Moreover, as some of the students may be engaged in a particular department of the works, or in a work devoted to the production of a speciality, the teacher may find a difficulty in selecting illustrations which appeal with equal force to all members of the class. Thus, in classes in engineering subjects the students may be employed in two or more works, manufacturing stationary, locomotive, or marine engines; mining,

chemical, textile or agricultural machinery; or machine tools. And while the general principles underlying all these are the same, there is much to be said for the view that the instruction should commence with the consideration of familiar examples, and that its scope should be widened as the students' knowledge of the principles becomes greater.

The difficulty is perhaps more apparent when it is called to mind that the students may be drawn from the pattern shop, foundry, smith's shop, fitting shop, turnery, boiler shop, and drawing office. And it is still greater when the class comprises in addition students who, while not engaged in the manufacture of machinery, desire to obtain some knowledge of its theory and construction, on account of its extensive application in their own industry.

In the teaching of applied subjects, like applied mechanics, machine construction, and steam, there is undoubtedly much to be gained by intelligently grouping students who have similar practical experience upon which to draw for illustrations. The advantage is greater in the earlier stages, and there are probably many cases in which the adoption of the method would not only be accompanied by increased efficiency, but also by more regular attendance. When once the initial difficulties have been overcome, the students should be encouraged, as a rule, to take a wider view of the subject, and those whose occupations differ considerably might be taught together. At the same time, some exceptions may be desirable, if the number of students permits such an arrangement to be economically carried out.

An example may be given in the case of boiler-makers, for whom a special course of drawing seems to be required. It is noteworthy that while the City and Guilds of London Institute has drawn up a syllabus for this class of student, there are only three registered teachers of the subject in the country.

In the case of Building, the only subject generally taught is that on the lines of the Board of Education syllabus. While this is suitable, and indeed essential for all engaged in the industry, some specific instruction in the separate branches is very important. Yet classes in "Carpentry and Joinery," "Brickwork and Masonry," are comparatively scarce. On the other hand, Plumbers almost invariably receive specific instruction in their craft, and only in rare cases attend the class in which the industry is considered as a whole. The same differences of prospective career exist here as in Engineering.

The Metallurgical industry presents similar problems. There are, broadly, two classes of men for whom training is required, viz.: Metallurgical Chemists and Metallurgical Engineers. The only suitable subjects taught in evening technical classes are Metallurgy, according to the syllabus of the Board of Education, and Iron and Steel according to the syllabus of the City and Guilds of London Institute. The former not only encourages a study of the general principles which underlie Metallurgical operations, but also, in its arrangement in sections, recognises to some extent the highly specialised character of the industry. The syllabus in Iron

and Steel is admirably adapted for those engaged in that branch of the industry, but classes in the subject are rare. Notwithstanding the importance of furnace construction to the Metallurgist, only one or two schools provide special instruction for this, and it cannot be said that either Machine Drawing or Building Construction, as usually taught, contain what is necessary.

The consideration of Mining Education raises the general question, whether the machinery user requires the same kind of instruction as those who are engaged in its manufacture. In the latter case, it is usual to confine attention to principles of design and construction. The man who uses machinery, however, seems to require a less minute treatment of these matters and more general treatment of a greater number of appliances. The colliery manager, for example, is more closely concerned with the efficiency of various types of pumps, and their suitability under certain conditions, and with the various methods of haulage and transmission of power, than with the statics of structures and mechanism. Is, then, the instruction in applied mechanics given to students engaged in engineering works equally suitable for him? The writer ventures to think not; but the subject is one which might give rise to a considerable difference of opinion. It may be pointed out, for instance, that these questions fall under the heading of Mining, and are dealt with in the class in that subject. While this is acknowledged, it may be doubted whether the treatment is adequate for the purpose in view,

which is to enable the colliery manager to understand the results of experimental work so thoroughly as to help him to make a choice when laying down new plant, and from time to time to assure himself by tests that such machinery is working with economy. For though this need may not be so apparent now, there are not wanting signs that in the future Coal Mining will have to be carried out under increased severity of competition and less favourable conditions than obtain at the present time. And it may be confidently predicted that the greatest advances in colliery working during the next twenty years will be due to developments in the application of machinery, and a greater regard to its economical employment.

While the difficulties considered in this section are often unavoidable, owing either to the comparatively small number of students in attendance, or to the extraordinary division of labour, their existence has been the means of discouraging students, and alienating the sympathy of employers. Cases are not wanting in which more careful attention to the points indicated would react favourably upon the growth and utility of evening technical schools.

E. Choice of Subjects.

One of the most remarkable features of Evening Technical Education in this country is the perfect freedom allowed to students as to choice of study. For years, beyond an injunction here and there to those who proposed to join a class in (say) Machine Drawing, to join also the class in Geometry, no

attempt has been made by technical teachers to exercise that discretion and influence over the pupils' studies which is the schoolmaster's prerogative.

The purely elective character of the University course in England and elsewhere[1] does not discount this criticism of Evening Schools, because in the former the students' studies are prescribed to a certain extent by the examinations in the faculty he has chosen, while in our Evening Schools the examinations are quite individual.

The result has been that students who cannot be supposed to know what they want have joined the class whose title seems to imply the most direct bearing on their trade, and have resolutely refused to join classes in subjects which are indispensable in explaining the "trade" subject. Students in Machine Drawing and Building Construction have declined to join classes in Geometry; students in Applied Mathematics and Steam have resolutely turned their faces from the attractions of Mathematics, with disastrous results to their progress in the selected subject. Teachers of Chemistry have been obliged to devote half the first session to Arithmetic and Elementary Heat, only to find when they had got over the mere rudiments that their students could never reach the higher stages without the help—direct and indirect—that a knowledge of Physics gives. Students present themselves for instruction in Metallurgy in absolute ignorance of

[1] See *Technics* for Feb., 1904. Professor Dalby quotes with approval the freedom which the German University student enjoys.

the Chemistry even of air and water, and without any knowledge of Drawing or Furnace Construction.

The following table gives the number of students who sat for examination in certain science subjects in 1902:

	Subject.	Number.
I.	Practical, Plane, and Solid Geometry,	2,997
II.	Machine Construction and Drawing,	8,345
III.	Building Construction, - - -	6,366
IV.	Naval Architecture, - - -	922
V.	Mathematics, - - - - -	12,564
V.*p*	Practical Mathematics, - - -	606
VI.*a*	Theoretical Mechanics (Solids), -	1,660
VI.*b*	Theoretical Mechanics (Fluids), -	766
VII.	Applied Mechanics, - - -	2,169
VIII.	Sound, Light, and Heat (Elementary),	678
VIII.*c*	Heat (Advd. and Hons.), - -	882
IX.	Magnetism and Electricity, - -	4.573
X.	Inorganic Chemistry (Theoretical), -	7,279
X.*p*	Inorganic Chemistry (Practical), -	4,664
XVIII.	Principles of Mining, - - -	1,994
XIX.	Metallurgy (Theoretical), - -	288
XIX.*p*	Metallurgy (Practical), - - -	245
XXII.	Steam, - - - - - - -	2,136

These figures, though they include day as well as evening students, but well repay analysis. Consider first Machine Construction and Drawing, Building Construction, Naval Architecture, and Principles of Mining, and assume that all students in Applied Mechanics and Steam are taking one or other of these. Let it be granted that such students require

instruction in Mathematics and Geometry. In round numbers we have:

Number of students taking Machine Construction and Drawing, Building Construction, Naval Architecture, and Principles of Mining,	17,000
Number of students taking Mathematics,	13,000
Number of students taking Geometry,	3,000

Allowing for the fact that students in Machine Construction and Drawing, Building Construction, Naval Architecture, and Principles of Mining, are almost entirely engaged in the respective industries, while students in Mathematics are not necessarily so engaged, the disparity is considerable. The case of Geometry is serious. This subject has for over thirty years been compulsory for Whitworth scholarships and exhibitions, and the prospectus of every technical school of note insists on a knowledge of Geometry as a basis of successful work in the subjects compared. If this regulation is not honoured more in the breach than in the observance, the state of affairs in the rest of the country must be bad indeed. In fact, the writer's own observations lead to the belief that teachers of this subject are becoming scarce, and the following figures showing the number of papers worked during three years fully account for it:

	1900.	1901.	1902.[1]
Number of papers in Subject I. worked,	11,628	4,691	2,997

[1] Examinations in the elementary stage of science subjects became optional in 1901. The percentage drop in papers worked in all subjects was 38, in Geometry, 60 per cent.

Examine next the case of Steam. Notwithstanding the fact that the syllabus includes a considerable amount of Heat, few will deny that a previous acquaintance with that subject is desirable for rapid progress. The total number of students examined in Elementary Sound, Light, and Heat, or in the Advanced or Honours stages of Heat, was roughly 1,500. Probably not more than half these were engineering students. Yet the number sitting for examination in Steam was more than 2,000. Allow here for the students who have obtained some knowledge of the fundamental subject by attendance at a secondary school, and that still leaves at least half the examinees with an unsatisfactory foundation.[1]

Again, by far the most popular subject in Physics is Electricity and Magnetism. No real progress can be made in this subject without some knowledge of Mathematics, Theoretical Mechanics, and Chemistry; no other subject requires such clear conceptions of energy in order that accurate notions may be developed. Thus:[2]

"One of the most serious mistakes in the Science teaching that is generally made is the choice of subject. That most commonly taken is Electricity and Magnetism, which is naturally very unsuitable for students with no previous knowledge of Science. The teacher, finding himself hampered by the fact that his students know nothing of the fundamental principles of Elementary Physics and Chemistry, tends to fall back on generalities; his teaching

[1] This is, of course, wholly apart from the fact that both types of student are found in the same class.

[2] Board of Education General Reports on Higher Education for 1902, p. 33.

becomes inexact, and the giving of information of a more or less scientific character does duty for Science teaching."

Twenty years ago there might have been some justification for an elementary descriptive treatment of Magnetism and Electricity. Little or nothing was then known of the electro-magnetic field, which concerned comparatively elementary students. But progress has been enormous, and dynamical conceptions have permeated the whole subject. The standard of the examinations has increased with the spread of facilities for instruction and the multiplication of text-books; and to-day no student who aims at exact knowledge can afford to regard it as an independent subject. The figures on page 78 are not without significance.

The unsuitability of choice is not only a common result of taking up too few subjects, but occurs also when the student has filled up his time pretty fully. The student with too narrow a training has his labours considerably increased, and is bound to suffer from want of exactness and definition in his ideas. On the other hand, too wide a curriculum leads to superficiality, and, occasionally, to mental and physical breakdown. How much an evening student can accomplish in any session depends upon previous education, ability, and strength of purpose. How much he can do with impunity—without serious injury to health—is another matter, and one not easily estimated before it is too late. In the programme of the Northampton Institute, Clerkenwell, (p. 55) it is stated that: "It has been assumed that an earnest student will be willing to devote three,

or in some instances, four nights a week to study during the winter months."

For the general run of students three nights a week may be regarded as a maximum, and if satisfactory progress is to be made, the greatest care is needed in organising the curriculum. There must be rational grouping and order of arrangement of subjects; the preliminary training of the students should be known exactly, in order to prevent the teacher groping in the dark; the actual work on which the student is engaged in the daytime should be kept in view, and account should be taken of his prospective career.

It is not intended to imply that these abuses exist everywhere—that there is no active control of the curriculum. There are indeed numerous instances in which heads of technical schools exercise a beneficent influence, and map out each student's work with admirable care. But there are hundreds of places in the country where there are no headmasters, and many others where the headship is nominal. In these cases each teacher is a "law unto himself." There is no co-operation between teachers, still less is there correlation of subjects. Every subject stands on its own basis. There is no guarantee of adequate preparation, no rational order and grouping, and nothing but an attenuated, ghostly caricature of a curriculum. For example: "Even in the same town and under the same Committee, one finds odd classes taken by independent teachers, who are only responsible individually to the Committee. There is no one to advise students what course to take, and indeed, the subjects

in which instruction is given depend on the teachers locally available. To this absence of direct control is due rivalry between classes in subjects which should appeal to similar types of students, and even the instinct of self-preservation does not prevent two or three classes in different subjects, each of which should be attended by the same students, being held at the same hour on the same evening. The distribution of classes amongst several schools in the same town is frequently due to want of adequate control and rival interests.

"Such distribution of classes leads to duplication of apparatus and waste of money; *e.g.*, a piece of apparatus is procured for illustration of Physiography; it is equally useful for Mechanics, or Building Construction, or Applied Mechanics, but these classes are in different buildings, under independent teachers, so each must have a similar piece of apparatus.

"As an example of lack of organisation, it may be mentioned that in one town there are eighteen classes in various subjects held at six different schools, and though in the centre of the iron industry, Metallurgy is not one of the subjects. The extreme distance between any two of the schools is half-an-hour's walk. Classes in Practical Mathematics, Building Construction, Applied Mechanics, and Steam are held at approximately the same hour on the same evening; the most central and comfortable school is only used for three subjects; though there is a good chemical laboratory there, and suitable rooms for Art instruction, the former subject is taught elsewhere in a laboratory cut out of half a chapel, and the latter

in a basement room, used in the daytime for Manual Instruction."[1]

This is a picture more or less true for scores of places. They are not schools, but mere segregations of classes, lacking in unity of aim and design, in economy of money, time, and effort, bringing technical education into disrepute, permitting the growth of vested interests, and constituting a serious stumbling-block in the path of progress.

[1] Board of Education Report, 1901, pp. 28, 29.

CHAPTER IV

TENDENCIES IN EVENING TECHNICAL INSTRUCTION

IF any justification is required in support of the criticisms in the last chapter, it is to be found in tendencies to their removal which are exhibited to a greater or less extent by all the more important Technical Schools. It will be convenient to describe these under the titles: Admission Standard and Age; Adaptation of the Instruction to the Special Requirements of Industry; and Organised Courses of Instruction.

A. Admission Standard and Age.

The evil which results from inadequate preparation is being grappled with in one of two ways. Either the student is referred definitely to the Continuation School, unless he can show that he possesses the necessary qualifications, or preliminary courses are held in the Technical School itself. The following examples show how in one or another of these ways an effort is being made to secure more satisfactory material.

At St. Helens, a compulsory preliminary course has been in operation for some years, and though the innovation was accompanied by a reduction in the number of new students enrolled, it has been

amply justified by increased efficiency. The subjects are Mathematics, Geometry, Elementary Science, and English.

Rochdale has introduced a similar obligatory course in Mathematics, English, Drawing, Physics, and Chemistry.

The Blackburn Technical School held an entrance examination in September, 1904, which is compulsory for all those who do not hold scholarships from the higher division of the Continuation Schools. Candidates for admission are examined in English, Arithmetic, Mensuration, Algebra, and Geometrical Drawing.

Stockport provides a preliminary course in Arithmetic, Freehand and Geometrical Drawing, and Elementary Science, and students are only excused if they can pass an entrance examination in these subjects.

At Liverpool, students are recommended to join the branch preparatory classes or the Continuation Schools before proceeding to the Technical School.

Students at Huddersfield are advised to take a course comprising Freehand and Model Drawing, Arithmetic and Mensuration, and Practical Geometry; at Derby the subjects are Mathematics, Machine Drawing, and Geometry.

Swindon suggests a preliminary course in Practical Mathematics, Practical Geometry, and Practical Mechanics.

Bradford has arranged a preliminary course for Engineering students in Mathematics, Geometry, and Drawing (with workshop practice if desired).

West Ham provides several courses. Thus

students engaged in Mechanical and Civil Engineering, Naval Architecture, Foundry Work, and Building, are recommended to do Preliminary Practical Mathematics and Technical Drawing; for those engaged in Electrical Engineering and Applied Chemistry, a class in Preliminary Physics is suggested in addition.

The standard of admission to the Manchester Municipal School of Technology is the Seventh of the Elementary School. In some cases where special preparatory knowledge is required, students must show that they are able to follow the instruction.

At Preston, students are recommended to attend the Continuation School unless they have a sound knowledge of the three R's.

In certain subjects at West Hartlepool, students are required to show that they possess the special knowledge which is necessary to enable them to follow the work, while Rutherford College, Newcastle-on-Tyne, follows the old plan of specifying certain requirements in connection with each subject of instruction.

No definite standard appears to be set up at Bristol. The Continuation School Scheme was described in Chapter II.

It may be noted that while there is considerable diversity of opinion as to what constitutes a complete preliminary course for technical students, there is agreement on certain essentials. Thus the nine cases given above, in which the subjects are specified, include Arithmetic, Mensuration, Mathematics, and some form of Drawing, Physics, Chemistry, or

Elementary Science only occur in four schemes. English would probably be an invariable constituent of courses in Continuation Schools, and appears in three of the courses mentioned above, which are held in Technical Schools. A general discussion of essentials has been given in Chapter II.

Comment has already been made upon the variability of age in evening technical classes. The lower limit imposed by the Board of Education, provided the student has left school, is twelve. While at present there is no uniformity in the regulations of the schools on this point, there is an indication of unwillingness to conform to the minimum. At Birmingham, students must be thirteen; at Brighton, fifteen; at Sheffield, Bristol, and Bradford, sixteen. In the latter place, an exception is made in favour of students who have passed through the preparatory district textile classes. There can be no doubt that but little serious technical instruction can be given to students under sixteen years of age.

B. Tendencies towards Adaptation to Industrial Requirements.

Until quite recently classes throughout the country have been conducted in accordance with the syllabuses of the central examining bodies. The growing specialisation of industry and the development of new manufactures have rendered new subjects necessary, and where these have not been introduced, the gap between the classes and the needs of neighbouring industries has become

wider. In other cases the additions to syllabuses issued by central bodies (*e.g.*, Building Construction) have been met by special classes in which instruction has been given to meet new requirements. Some of the innovations may be briefly noticed.

At University College, Sheffield, there is a course on Machine Tool Work, which deals with those matters which a man may spend years in the shops without learning. Students are not admitted unless they have (*a*) been in the works for at least three years, and have been engaged in working machine tools during a portion of that time, or can pass an examination in vice-work and the simple manipulations of machine tools; (*b*) have attended science classes for at least one year previously and obtained a certificate in Machine Drawing, or can show that they possess equivalent knowledge.

The syllabus is as follows:

The cutting of spur, bevel, worm, and other kinds of wheels in the milling or planing machine.

The making of formed cutters for wheels and twist drills. Making of forming tools for lathe work, or work of an irregular shape.

The making of universal and independent chucks, drill chucks, Morse taper drill sockets; lathe arbors.

The making of spiral, angular, and T-slot cutters, end mills, counterbores, twist drill cutters, twist drills, parallel and taper reamers.

Grinding twist drills, spiral, angular, and T-slot cutters, reamers, hard steel mandrels, arbors, spindles, etc.

The making of jigs for drilling, milling, and grinding machines for repetition work.

Practice in the use of the hexagon turret lathe. Making, grinding, and setting tools for turret lathe. Turning repetition formed work up to 2 in. in diameter and 27 in. in length.

Practice in the use of limit and other gauges.

Testing accuracy of work in the lathe, planing, drilling, and grinding machines.

Testing truth of lathe arbors and centres, drilling machines, and planing machines.

The following syllabus of work is being carried out at the Leicester Municipal Technical School:

MATERIALS.

COMMON WORKSHOP MATERIALS.

Cast and malleable cast iron, wrought iron and steel, copper and brasses, zinc, lead, and wood. Brief study of the sources and methods of production of metals in the form of plates and bars.

Specimens of ore, pig, cast, and rolled metals.

The character of the Bessemer, open hearth, and crucible processes of steel making. Case-hardening iron.

Fractures of different metals. The corresponding crystalline structure of polished specimens exhibited in the microscope.

Malleability, ductility, hardness. The hardening effect of pressure. The superficial effect of hammering.

The various effects of thermal treatment upon different metals.

SPECIAL STUDY OF TOOL STEEL

Appearance of fractures of steels containing various percentages of carbon, and of air hardening steels.

Corresponding appearances in the microscope of etched and polished specimens.

The plastic, granular, and molten states of steel.

Cooling curves. Visible recalescence. The pyrometer.

Effect of different heat treatments on fracture and crystalline structure.

Examination with the microscope of polished and etched specimens of the same steel with various thermal treatments.

Measurement of hardness of hardened tool steel. How its hardness varies with temperature. Modern high speed steel.

Internal strains set up when a mass of steel is heated or cooled. Analogy to the cooling of the earth and earthquakes. Cracking and warping, and their causes. Permanent expansion or contraction.

Heating steel for hardening. Objections to open fires and blow pipes. The lead bath. The muffle. Surface protection.

Practical use of the pyrometer, and other heat gauges.

Cooling steel for hardening. Representative cooling media: Air, oil, water, salt water, and mercury. Their modes of action and applications to different uses.

Importance of equal and simultaneous cooling of the mass.

Quenching symmetrical and unsymmetrical pieces, and means for reducing local shrinkage strains.

Subsequent tempering, and the practical measurement of temperature for this purpose.

Colours of oxidation. Use of lead and oil baths, and the flaring of oil.

Cooling after tempering. Repeated tempering. Seasoning steel.

Annealing tool steel. Water annealing.

WORKSHOP PROCESSES FOR SHAPING MATERIALS.

PROCESSES FOR SHAPING BY PRESSURE OR DRAWING, WITHOUT HEAT.

The plasticity of metals at ordinary temperatures. Malleability and ductility.

Microscopic study of the structural changes and flow of metal which occur when a bar is bent.

Examples of coined work, collapsible tubes, gold leaf, sheet lead bossing, pressed steel cycle parts, cartridge shells, and drawn tubes and rods.

Limitations of the process. Hardening of metals under treatment. Cause and avoidance of rupture. Permanent internal strains produced by pressure.

Effect of time on the plasticity of metals. Likeness to the behaviour of pitch.

Exercises.—Rolling metal strips. Coining soft metals. Riveting. Knurling. Centre and figure punching. Burnishing. Sizing holes with plain drifts. Planishing metal sheets to remove buckles. Drawing wire. Drawing cups in a press. Spinning. Bossing sheet lead. Bending and straightening wire.

Visits to works where operations of shaping metals cold by pressure may be seen.

PROCESSES FOR SHAPING BY PRESSURE AIDED BY HEAT.

How the plastic properties of metals vary with temperature. Tests under heat in the testing machine.

Distinction between metals and alloys. Reducing brass to powder.

Hot rolling of metals into rods and sheets. The influence of time. The steam hammer and hydraulic forging press.

Visits to smithies to see various forgings.

Exercises.—Hot rolling of metal strips. Upsetting and making rivets. Hot riveting. Drawing out and bending smith's work.

The plastic state of alloys. Squirting "compo" pipes and bullet rod.

"Extrusion of metals." Specimens of pipes, cable sheathing, and extruded metals.

PROCESSES OF SHAPING BY FUSION AND CASTING.

Visit to a foundry, and explanation of foundry methods.

Exercises.—Preparation of sand moulds from:

(*a*) A semi-cylindrical pattern.
(*b*) A second side added to pattern by dowels.
(*c*) The alternative use of match plate.
(*d*) A solid pattern with irregular parting.
(*e*) Moulding in three part box.
(*f*) Cylindrical core.
(*g*) Irregular core for hollow casting.

Core supports. Gates and vents. Porosity of moulds and cores.

Casting by students in their own moulds with white metal.

Shrinkage in cooling. Feeding. Draw and blow-holes.

Inevitable shrinkage strains. Specimens of castings fractured in cooling.

Second visit to foundry.

Force in casting, supplementary to force of gravity.

Specimens of cast types and "finished castings."

PROCESSES OF SHAPING BY ADDITION AND SURFACE FUSION.

General principles. Importance of cleanliness. The use and action of fluxes, as: Tallow, resin, zinc chloride, borax, sand.

Exercises.—Soft soldering sheet metal with copper bit. Soft soldering heavier masses with the blow-pipe. Making plumbers' wiped joints. Soft soldering cast iron. Silver soldering wire, brazing a cycle joint, a brass tube, and a copper ball. Brazing cast iron.

Welding iron and mild steel and higher carbon steel.

PROCESSES OF SHAPING MATERIALS BY CUTTING.

The essential nature of cutting action.

Difference between cutting and splitting illustrated in cutting wood along the grain. Difference between cutting and shearing illustrated by the wood saw or parting tool.

Study of the strains produced by a cutting tool in a homogeneous material, as in paring the edge

of sheet lead with a chisel, or on a large scale with tempered clay and a wooden chisel.

The effect of lubrication.

Complete penetration and severance of the material by the cutting edge, essential to perfect cutting action and the production of a smooth surface. Impossibility of producing smooth surfaces by shearing. Effect of bluntness of the tool.

Study in the lathe, and with the microscope, of the mode of separation of chips of various thickness from cast iron, tool steel, mild steel, and copper, and of the effect thereon of varying cutting angles. Top and bottom rake. Effective bottom rake dependent on rate of feed. Bending chips of straight and of curved section.

Characteristics of roughing and finishing tools, and the avoidance of shearing action in the latter.

The blunting of tools by abrasion, and by heating. High speed steels. Cutting speeds and feeds. Chattering and its causes. Accuracy of cutting action.

Characteristic features of machines for operating cutting tools, as the lathe, shaper, milling and drilling machines.

Study of the characteristics and action of turning and planing tools for various purposes, of milling cutters and files, drills, reamers, taps, and dies.

Exercises.—Sharpening Tools.

Lathe Work.—Chucks and chucking. Holding without distortion. Centres and centring. Carriers. Live and dead centres. Steadies. Adjusting the lathe. Turning cylindrical pieces. Cones. Facing. Boring. Reaming. Screw-cutting. Hand-turning. Turning irregular forms.

Shaper Work. — Holding the work. Holding without distortion. Three point bearings. Shaping a true plane. Two parallel planes. Planes at various angles. Cylindrical and irregular forms.

Milling.—Milling plane surfaces with spiral mills and end mills. Milling with gang mills. Milling irregular forms. Milling slots. Milling with hand and power feeds.

Drilling.—Use of common flat drills, twist, and straight fluted drills. Hand and power feeds. Drilling jigs. Counterbores and facing cutters. Machine and hand reamers.

Tapping. — Tapping by hand and machine. Sharpening taps.

ABRASIVE PROCESSES.

Study under the microscope of an abrasive particle scratching the surface of various materials at low speeds. Effects of plasticity and hardness. The effect of high velocities and heating of the work.

Common abrasives — Gritstone, oilstone, sand, powdered glass, emery, carborundum, diamond.

Methods of supporting abrasives in glass and emery paper, in polishing wheels, in vitrified emery and carborundum wheels.

Shellac wheels and the use of metal laps.

Study of the breaking down action of emery wheels, and the relation of grades and grains to velocity, and to the material ground.

Grinding to remove material. Grinding for a finish. Accuracy of grinding.

The nature of polishing action studied microscopically. Polishing steel and brass, etc.

Exercises.—Rough grinding a soft steel shaft. Finishing. Grinding hardened steel and cast iron. Surface grinding. Sharpening cutters. Polishing steel and brass.

THE HAMMER.

Uses and abuses of the hammer. Effects of hard steel hammers. Relation of size of hammer to purpose. The plastic lead hammer. The elastic mallet.

MEASURING AND GAUGING.

Accuracy of form and finish. Economic value of accuracy. Interchangeability. Degrees of accuracy. Standards of length. Sub-division of standards. Conveniences of binary and decimal divisions. Workshop standards. Principles to be observed in using calipers. Personal equation. Micrometers. Verniers. Systematic gauging. Limit gauges. Shrink fits, driving fits, running fits.

Objection may be taken to these syllabuses on the ground that they aim at teaching a trade, and that therefore they are outside the scope of what the Legislature has defined as legitimate subjects for public expenditure. It has, however, already been observed that it is extremely difficult to separate the teaching of principles from the teaching of practice, and in the eyes of some people, extremely undesirable also. And it is, moreover, quite impossible in many cases to judge whether the limitations are exceeded from a study of the syllabus.

The question is determined entirely by the method of treatment in class, and the syllabuses permit of a thoroughly scientific method of presentation, while they deal with subjects of the highest importance. No one can read current engineering literature without being impressed by the superiority of American methods. American machine tools have had an enormous effect in reducing the cost of production, and have practically revolutionised some branches of industry, of which watch- and clock-making may be cited as an example.

The information contained in the above syllabuses should be part and parcel of a shop foreman's equipment. At the same time, the number of really qualified men of this type available is small. Thus, in a paper read at a conference of science teachers at University College, Sheffield, on 11th January, 1900, Professor Ripper said:[1]

"It is clear from what has already been said that we need the means of securing a steady supply of skilled machinists and toolmakers with a competent knowledge of up-to-date methods of turning work out, and of the best types of machine tools—men, in fact, who are competent to become, in course of time, leading men and works' foremen.

"There are, of course, works' foremen in England second to none in the world, but everyone knows, who has any knowledge of works, that such men are singularly scarce, and when a vacancy occurs, extremely difficult to replace. These men are the brain of the workshop, and upon their skill depends

[1] *Nature*, 8th February, 1900.

very much of the true success of any manufacturing concern. Almost any man in the works could be more easily replaced than the skilled works' foreman."

A reasonable conclusion would be that there is also a dearth of teachers capable of giving the requisite instruction.

Another interesting course is that on Foundry Practice at the West Ham Technical School. The following subjects are treated of in the Lectures:

Properties and mixtures of pig iron; fuel, furnaces, refractory materials; methods of blast production; crucibles, ladles, and foundry tools; green sand, dry sand, and loam, their preparation and moulding in them; drying stoves; malleable cast iron; chill castings; case hardening; casting on to other metals; special methods of casting; machine moulding; cleaning and dressing castings.

Brass, gun-metal, and other common alloys, their compositions and methods of melting and casting in them.

Methods of costing work.

The freedom to draw up schemes and time-tables conferred on local authorities by the Board of Education,[1] together with the readiness of the City and Guilds of London Institute to modify their syllabuses as occasion may require,[2] will probably lead to an increase in the amount of such instruction,

[1] Regulations for Evening Schools, 1904, p. 3 *et seq.*

[2] Report of City and Guilds of London Institute, 1902.

but the provision of competent teachers who have sufficient scientific knowledge to treat the subjects from a proper standpoint will be a serious obstacle.[1]

Of considerable interest, too, is the syllabus in Sanitary Engineering at the Manchester School of Technology, which includes matter generally taught under the separate heads of Building Construction and Hygiene. The enormous growth of large industrial centres has created the need for numbers of Sanitary and Building Inspectors, etc., in order that the health of the community may not suffer through carelessness or wilful negligence.

One of the most serious defects in the instruction of engineering and building students is the lack of attention to the nature and properties of materials. At the Birmingham Municipal Technical School there is an advanced course suited to the needs of Civil and Mechanical Engineers and Architects which to some extent supplies this deficiency. A good deal of it might be described as descriptive engineering. The syllabus is as follows:

PART I. *Ironwork*—The manufacture of cast iron, wrought iron, and steel; description of the plant used in modern iron and steel works; the different kinds and qualities of cast iron, wrought iron, and steel; the commercial forms of iron and steel; pattern-making and moulding; iron and steel casting; the mechanical properties of cast iron, wrought iron, and steel, and the methods of testing; the practical value

[1] See also syllabuses of special trade classes held at the Birmingham Municipal Technical School, the Northampton Institute, Clerkenwell, and other institutions.

of various metalloids in cast iron and steel; the use of iron and steel in engineering structures and machinery; the manufacture and erection of structural ironwork. *Other Metals and Alloys*—Their strength and principal uses in engineering. *Modern Machine Tools*—Description of modern machine tools and labour-saving appliances; general arrangement of engineering works.

PART 2. *Earthwork*—Stability of earth; effect of water on stability; cuttings, embankments, and dams; clay puddle, its preparation and use; foundations for buildings, bridges, and machinery; methods of laying submerged foundations; sinking shafts; tunnelling; dredging; description of the plant used for earthwork operations. *Masonry*—Strength and properties of various stones; different classes of masonry; the selection and preparation of stone for different kinds of engineering work. *Brick, Cement, and Concrete*—Their manufacture, properties, strength, methods of testing, and use in engineering work. *Timberwork*—The principal kinds of timber and their use in engineering; strength of timber; preservation of timber.

The strength and properties of the materials will be demonstrated in the Engineering Laboratory.

The introduction of Mechanics into the Board of Education Syllabuses in Building Construction has been met in a number of instances by special courses of instruction in graphic statics. An arrangement of this sort has been made at Derby, Birmingham, Manchester, Brighton, Darlington, etc. At Salford there is a special course in Builders'

Mechanics. In regard to the arrangement of classes in Chemistry and Physics with reference to their applications to particular trades, the most notable examples are in connection with Plumbing. A considerable number of Technical Schools now provide special classes for this trade, in which an elementary knowledge of Physical Science is of the greatest importance. Examples of special classes for Engineering and other industries are seldom met with. At the same time large schools, such as those at Manchester and Bradford, hold classes in Physics—covering the whole ground of the subject—which are specially recommended as forming a necessary basis for advanced technical studies.

An attempt has been made in the larger institutions to meet the particular needs of students by treating highly specialised branches separately, and often in short courses. Thus, Applied Mechanics may be treated in sections, each dealing with a particular part of the subject. The most remarkable example of this method is probably to be found at the Northampton Institute, Clerkenwell, where a limited number of teachers give instruction in short "unit" courses, which apparently can be grouped to suit any need that has arisen, or is likely to arise.

Finally, the following list[1] of subjects, bearing upon the industries considered, in which grants were claimed from the Board of Education in 1902-3, will indicate the activity which is being displayed throughout the country in meeting the need which has been created by industrial specialisation.

[1] Report of the Board of Education for the year 1903-4.

Plumbing.
Bricklaying and Masonry
Staircasing and Handrailing.
Surveyors' Quantities.
Builders' Quantities.
Painters' and Decorators' Work.
Chemistry for Builders.
Fitters' and Turners' Work.
Pattern Making.
Cycle Construction.
Marine Engineering.
Mine Surveying.
Metal Plate Work.
Sanitary Engineering.
Carpentry and Joinery.
Carriage Building.
Iron and Steel Manufacture.
Assaying and Ore Dressing.
Boiler Making.
Boiler Testing.

Some of these are from the Programme of the City and Guilds of London Institute, but many are special local syllabuses drawn up to meet local needs. The list does not include the usual science subjects of the Board of Education.

C. Organised Courses of Instruction.

Though for a number of years the larger Technical Schools have done much in their Prospectuses, or through the teachers, to encourage students to attend such classes as will secure a more or less

rational order and grouping of subjects, the tendency has been more marked and widespread in recent years. Most Technical Schools of any note have drawn up tables showing the order and grouping of subjects for particular trades, but while in all cases students are strongly advised to follow the systematic courses of instruction, only three have, so far as the writer is aware, made such courses compulsory. As a general rule, the plan has been to take subjects from the Board of Education Directory and the Programme of the City and Guilds of London Institute, and to weld these into trade groups; but in a few cases special courses of Lectures and Practical Work have been instituted in subjects which none of the Central Examining Bodies have as yet recognised by the provision of an annual test. In discussing the courses of instruction, it will be convenient to consider them under the titles of the trades, rather than of the schools. This will be consistent with the attitude adopted throughout this work, in which it is regarded as essential that the instruction and organisation should be based upon the industrial considerations.

I.—*General Mechanical Engineering Courses.*

The suggested duration of the courses is from three to five years. In only three cases are compulsory preliminary courses provided, viz.: at Stockport, St. Helens, and Rochdale. So far as the courses themselves are concerned, there is considerable difference of standard, and no small want of unanimity as to subsidiary subjects.

The following table is an analysis of the courses

given on pp. 110-120; the figures represent the number of courses in which one, two, or more years are devoted to each subject:

Subject.	One Year	Two Years	Three Years	Four Years	Five Years	Six Years
Mathematics, - -	2	13	6	5	1	—
Geometry, - -	7	11	5	—	—	—
Machine Drawing, -	1	5	13	4	2	—
Applied Mechanics, -	1	12	7	4	—	1
Steam, - - -	2	14	3	5	—	—
Theoretical Mechanics	5	1	1	—	—	—
Sound, Light, & Heat,	6	2	—	—	—	—
Heat, - - -	2	—	—	—	—	—
Chemistry, - -	1	2	—	—	—	—
Metallurgy, - -	1	1	—	—	—	—

The general aim is to give the students a progressive course of instruction which shall culminate in the second or third stages of Machine Drawing, Applied Mechanics, and Steam. In order to attain this, various views appear to be held as to the amount of Mathematics and Geometry required to render the more technical subjects intelligible. So far as the first-named subject is concerned, it is extraordinary that any teacher should regard one year as sufficient, unless the standard on entrance is exceptionally high. Even two years, which the majority of courses entail, is little enough. A particularly interesting feature is the number of cases in which Practical Mathematics is taken, no less than nineteen out of twenty-six courses including that subject. In regard to Geometry, the difficulty seems to be to decide whether anything

beyond the elementary stage is essential. Of the eleven courses in which two years are devoted to the subject, about half are aiming at Stage I., and the rest at Stage II. For most classes of work in Machine Drawing, Stage I. of Geometry is ample, while for higher work in Applied Mechanics, the necessary graphics would fall on Stage II.

No one can read intelligently an engineering text-book or journal without some knowledge of Physical Science. This statement is truer every day, and it is of interest to inquire what notice has been taken of this point in arranging the curricula under consideration. Only six courses provide instruction in Sound, Light, and Heat, and two in Advanced Heat. The introduction of Heat has doubtless been delayed to a considerable extent by its association in the elementary stage with Sound and Light—subjects which have but a small bearing upon the work of an engineer, however important they may be as part of a liberal education. Physics cover a wide area, and the division into Sound, Light, and Heat, and Electricity and Magnetism, is almost universal. At the same time, there is no inherent reason why Heat should not be taught separately. One of the consequences, however, is that out of twenty-four courses in which Steam is taught, twelve[1] make no provision for instruction in Heat. Of course, in most cases, the teacher of Steam includes a certain amount of Heat in his lectures. How far this may be sufficient

[1] Elementary Science or Physics is part of Preliminary Courses at Rochdale, St. Helens, and Stockport. Also Practical Class in Steam at Salford is really Practical Heat.

depends largely upon the individual, and in any case he would probably prefer students with a satisfactory preliminary training.

The applications of Chemistry to Engineering are now increasing, and the desirability of students having some knowledge of Metallurgy has occasionally been emphasised. Three schools insist on Elementary Science (Physics and Chemistry) in the preliminary course, but beyond that only three courses contain Chemistry, and two of these add Metallurgy. Birmingham has a course on the Materials of Engineering and Processes of Construction, which includes the essentials of Metallurgy, Nature of Building Materials, and some Applied Mechanics. To those whose duty it is to follow closely improvements in Materials, this lack of instruction in Chemistry cannot fail to be a serious loss.

The fact that many classes, especially in large towns, contain a fair proportion of students who have passed through secondary schools is not here lost sight of. But in the absence of a definite standard of admission in these subjects, too much should not be taken for granted. Most of the courses give evidence of having been carefully thought out; a few are not only educationally unsound, but have the misfortune of being at variance with the time-table. The latter are inserted as a warning.

The majority occupy three nights a week; a few only two nights; while several require every night in the week. Thus out of twenty-three courses, for which data have been collected, fourteen devote three

nights a week in the first year, thirteen three nights a week in the second year, and thirteen three nights a week in the third. There is thus fair agreement as to the number of nights' work a week which can be expected from the average student. A greater number of nights per week than three cannot be considered satisfactory unless due to the inclusion of Laboratory or Workshop instruction. Practical work is less fatiguing than the close mental attention required to follow lectures, and it does not as a rule increase the amount of reading required from the student. To what extent it should be introduced into Evening Technical Education will be considered in Chapter VII.

Some of the courses deserve special mention. It has been said that the general aim is to lead the student through a progressive course of instruction in the specifically engineering subjects until he reaches a standard of knowledge represented by the second stage in a three or four years' course, or the third stage, or higher, in a six years' course. This is in the main true; but there are some points of difference. Thus the courses at Bolton appear to aim at giving the student a general grounding in the subjects which underlie Engineering, rather than to aim at a higher standard in Mechanics, Steam, or Machine Drawing, as in other five year courses (*cf.* Newcastle). The extent of difference in providing instruction in the fundamental subjects has been already noted. West Ham follows the courses for the degree in Engineering at the University of London. In these syllabuses, subjects are grouped below the

senior stages: thus Mechanical Engineering includes both Applied Mechanics and Steam, and Engineering Drawing, Geometry and Projection. This simplifies the time-table. The senior stages are broken up, and the special courses, B D and E, are similar to those in the fifth year at Birmingham, and the fourth and fifth years at Manchester.

ORGANISED COURSES OF INSTRUCTION

I. Mechanical Engineering.—*Three Year Courses*

First Year	Second Year	Third Year
STOCKPORT		
Practical Mathematics, St. I. Practical Geometry, St. I. Machine Drawing, St. I. 3 nights—6 hours	Geometry, St. II. Machine Drawing, St. II. Applied Mechanics, St. I. Steam, St. I. 3 nights—6 hours	Practical Mathematics, St. II. Machine Drawing, St. II. Applied Mechanics, St. II. Steam, St. II. 3 nights—6 hours
ST. HELENS—GAMBLE INSTITUTE		
Practical Mathematics Machine Drawing Theoretical Mechanics Applied Mechanics Steam 3 or 4 nights—6 or 8 hours	Practical Mathematics, etc., as in first year 3 nights—6 hours	Machine Drawing 2 nights—4 hours
DERBY		
Mathematics Geometrical Drawing Theoretical Mechanics 3 nights—4 hours	Mathematics Machine Drawing Applied Mechanics (Theo. and Pract.) Practical Geometry Steam 4 or 5 nights	More advanced work in second year subjects, with Lectures on Mechanical Engineering

ORGANISED COURSES OF INSTRUCTION—*Continued*

First Year	Second Year	Third Year
BRADFORD		
Mathematics Physics Applied Geometry Draughtsmanship [Workshop] 3 nights—6 hours	Mathematics Physics (as in first year) Applied Geometry Draughtsmanship Steam Engines Testing Laboratory 3 nights—6 hours	Mathematics Draughtsmanship Engine Testing Testing Laboratory 3 nights—4 hours
SWANSEA		
Practical Mathematics Geometry Applied Mechanics Machine Drawing [Workshop] 5 nights	Geometry, St. I. or II. Machine Drawing, St. II. Applied Mechanics, St. I. or II. Experimental Mechanics Steam, St. I. Workshop (?) nights	Machine Drawing, St. II. or III. Geometry, St. II. Steam, St. II. Applied Mechanics, St II Experimental Mechanics Steam Engine and Boiler Trial 4 nights
PRESTON		
Workshop Arithmetic Practical Geometry, St. I. Applied Mechanics, St. I. Steam, St. I. 3 nights—4½ hours	Practical Mathematics, St. I. Applied Mechanics, St. II. (Theo. and Pract.) Machine Construction, St. I. 3 or 4 nights—5 or 6½ hours	Mathematics, St. II. Steam, St. II. (Theo. and Pract.) Machine Construction, St. II. 4 nights—5 hours

ORGANISED COURSES OF INSTRUCTION—*Continued*

First Year	Second Year	Third Year
SWINDON		
Practical Mathematics Practical Mechanics and Steam Geometrical and Machine Drawing Heat, Electricity, and Chemistry 3 nights—6½ hours	Practical Mathematics, etc., as in first year	Practical Mathematics, St. II., with two of the following:—Geometry, St. II.; Steam, St. II.; Machine Drawing, St. II.; Applied Mechanics, St. II.; or Intermediate Electricity
PEOPLE'S PALACE, LONDON		
Mathematics, St. I. Geometry, St. I. Machine Drawing, St. I. 3 nights—10/-	Mathematics, St. II. Geometry, St. II. Machine Drawing, St. II. Theoretical Mechanics, St. I. Applied Mechanics, St. I. Steam, St. I. 5 nights—15/-	Mathematics, St. III., IV., V., or VI. Machine Drawing (Honours) Applied Mechanics, St. II. Steam, St. II. 4 nights—15/-
NORTHAMPTON INSTITUTE, CLERKENWELL—*Courses* 9, 10, *and* 11		
Workshop Drawing Workshop Calculations Mechanics and Mechanism (Lecture and Laboratory) Tools and Modern Workshop Practice (October to January)	Prime Movers (*A*) (Lecture and Laboratory) Materials (Lecture and Laboratory) Workshop Calculations	Machine Design and Graphics Engineers' Quantities and Estimates (ten Lectures) Hydraulic Engineering (fifteen Lectures) Prime Movers (*B*) (Lectures—Laboratory optional)

ORGANISED COURSES OF INSTRUCTION—*Continued*

WOOLWICH

First Year	Second Year	Third Year
A Mathematics, St. I. or II. Mechanical Engineering (Ord.) Experimental Mechanics Machine Drawing		
B Mathematics, St. I. or II. Applied Mechanics, St. I. Theoretical Mechanics Machine Drawing	Mathematics, St. II or III. Steam, St. I. or II.; or Engineering Laboratory Applied Mechanics, St. II. Machine Design, St. II.	Mathematics, St III., V., or VI. Mechanical Engineering (Honours) Machine Drawing or Geometrical Drawing Engineering Laboratory
C Mathematics, St. I. or II. Steam, St. I. Practical Mathematics, St. I or II. Mechanical Engineering (Ord)		
D Mathematics, St. I. or II. Applied Mechanics, St. I. Sound, Light, and Heat Machine Drawing		
E Mathematics, St. I. or II. Electricity and Magnetism, St. I. (Theo. and Pract.) Applied Mechanics, St. I.; or Mechanical Engineering (Ord.) Experimental Mechanics or Machine Drawing		

ORGANISED COURSES OF INSTRUCTION—*Continued*

Four Year Courses

First Year	Second Year	Third Year	Fourth Year
HUDDERSFIELD			
Workshop Mathematics Geometry Machine Drawing Workshop 4 nights—6 hours	Mathematics (Practical) Machine Drawing Applied Mechanics (Theoretical and Practical) Steam (Theoretical and Practical) 4 nights—7 hours	Machine Drawing Geometry Applied Mechanics (Theoretical and Practical) Steam (Theoretical and Practical) 4 nights	Machine Drawing Geometry Mechanics (Theoretical and Practical) Steam (Theoretical and Practical) 4 nights
LIVERPOOL			
Calculations for Engineers Mathematics, St. I. Machine Drawing, St. I. Preparatory Practical Mechanics	Mathematics, St. I. Practical Geometry, St. I. Machine Drawing, St. I. Theoretical Mechanics, St. I., and, if possible, Sound, Light, and Heat, St. I.	Practical Mathematics Applied Mechanics and Steam. with Laboratory Work Magnetism and Electricity, St. I Electrical Engineering	Mathematics, St. II. Applied Mechanics, St. II,, with Laboratory Work Steam, St. II., with Laboratory Work Magnetism and Electricity, St. II. Machine Drawing, St. II.
BRIGHTON			
Mathematics, St. I. Practical Geometry General Elementary Science Principles of Mechanics Machine Drawing Fee, 15/-, or 3 subjects, 12/-	Mathematics, St. II. Practical Geometry Principles of Mechanics Machine Drawing Fee, 15/-, or 3 subjects, 12/-	Mathematics, St. II. or III Practical Geometry, St. II. Principles of Mechanics, St. II. Applied Mechanics, St. I. or II. Machine Drawing, St. II.	Mathematics, St. V. Heat, St. II. Steam, St. II. Applied Mechanics Machine Drawing

ORGANISED COURSES OF INSTRUCTION—*Continued*

WEST HARTLEPOOL

First Year	Second Year	Third Year	Fourth Year
Practical Mathematics Geometry, St. I. Machine Drawing, St. I. 3 nights—4 hours	Practical Mathematics Geometry, St. II. Machine Drawing, St. II. Sound, Light, and Heat 4 nights—5 hours	Machine Drawing, St. II. Applied Mechanics, St. I. Steam, St. I. 2 nights—3 hours	Applied Mechanics, St. II. Steam, St. II. Heat, St. II. 3 nights—3 hours

ROCHDALE

First Year	Second Year	Third Year	Fourth Year
Practical Mathematics Practical Geometry Machine Drawing, St. I. 3 nights—6 hours	Machine Drawing, St. II. Practical Geometry, St. II. Applied Mechanics, St. I. 3 nights—6 hours	Machine Drawing, St. II. Practical Geometry, St II. Steam, St. I. 3 nights—6 hours	Machine Drawing, St III. Applied Mechanics, St. II. Steam, St. II.

DARLINGTON

First Year	Second Year	Third Year	Fourth Year
Mathematics Machine Drawing, St. I. Sketching Steam Preliminary, or Electricity and Magnetism 3 nights	Practical Mathematics Machine Drawing, St. II. Applied Mechanics Marking-off, or Electric Lighting nights	Practical Mathematics Preparation of Working Drawings Applied Mechanics Steam Marking-off, or Electric Lighting	Practical Mathematics Machine Drawing Steam Applied Mechanics, or Electric Lighting

ORGANISED COURSES OF INSTRUCTION—*Continued.*

WEST HAM

First Year	Second Year	Third Year	Fourth Year
Mechanical Engineering (Jun.) Engineering (Drawing) (Jun.) Mathematics (Intermediate) 3 nights—5 hours	Mechanical Engineering (Inter.) Engineering (Drawing) (Inter.) 3 or 4 nights—6 or 9 hours	Mechanical Engineering (Sen.) Mathematics (Sen.) Engineering (Laboratory) 3 nights—6 or 7 hours	Mechanical Engineering (Sen.) Engineering (Laboratory) 3 nights—7 hours

PLYMOUTH

First Group	Second Group	Third Group	Fourth Group
Mathematics, St. I. Geometry, St. I. Theoretical Mechanics, St. I. Sound, Light, and Heat, St. I. 4 nights	Mathematics, St. II., or Practical Mathematics, St. I. Machine Drawing, St. I. Applied Mechanics, St. I. (Theoretical and Practical) Steam, St. I. 3 nights	Mathematics, St. III., or Practical Mathematics, St. II. Machine Drawing, St. II. Applied Mechanics, St. II. (Theoretical and Practical) Steam, St. II. Mechanical Engineering 3 nights—Ordinary Grade	Machine Drawing Applied Mechanics Steam Mechanical Engineering (Hons. Grade) 4 nights

ORGANISED COURSES OF INSTRUCTION—*Continued*

Five Year Courses

BIRMINGHAM

First Year	Second Year	Third Year	Fourth Year	Fifth Year
Practical Mathematics Machine Drawing, St. I. Practical Geometry, St. I.	Practical Mathematics Mach. Drawing, St. II. Applied Mechanics (Theo. and Pract.) Mechanical Engineering (Ord. Course)	Graphic Statics App. Mechanics, St II. (Theo and Pract.) Steam, St. I. (Theo. and Pract) Materials and Processes of Construction	Steam, St. II. (Theo. and Pract.) Machine Drawing Mechanical Engineering (Hons. Grade) 3 nights—7 hours Special Courses on Iron and Steel (Theo and Pract) or Electrical Engineering	Indicator Diagrams Structural Design Gas and Oil Engines Hydraulic Engineering 3 nights—4 hours Electrical Engineering
3 nights—6½ hours	4 nights—9 hours	3 nights—6 hours		

MANCHESTER

First Year	Second Year	Third Year	Fourth Year	Fifth Year
Practical Mathematics Geometry Machine Drawing	Practical Mathematics Mechanics Machine Drawing Steam	Practical Mathematics Mechanics, with Laboratory Steam, with Laboratory	Practical Mathematics Strength of Materials and Laboratory Work Theory of Heat Engines with Laboratory Work	Hydraulics, with Laboratory Work Theory of Machines, with Laboratory Work Gas Engine Laboratory Refrigerators
3 nights—6 hours	3 nights—6 hours	3 nights—6 hours		

ORGANISED COURSES OF INSTRUCTION—*Continued*

KEIGHLEY

First Year	Second Year	Third Year	Fourth Year	Fifth Year
Practical Mathematics Geometry Applied Mechanics Machine Drawing	As in first year	Machine Drawing Applied Mechanics Steam	As in third year	Practical Mathematics Applied Mechanics Machine Drawing Mechanical Engineering Also in sixth year
2 nights	2 nights	2 nights	2 nights	2 nights

BOLTON—(a) Draughtsmen

First Year	Second Year	Third Year	Fourth Year	Fifth Year
Mathematics Geometry Machine Drawing	Geometry, St. II. Mach. Drawing, St. II.	Practical Mathematics Mathematics, Sec. II. Steam, St. I. Sound, Light and Heat	Workshop Theoretical Mechanics (Solids) Theoretical Mechanics (Fluids) App Mechanics, St. II. Steam, St. II	Machine Drawing (Hons.) Magnetism and Electricity, St. I. Electrical Engineering (Theo. and Pract.)
5 hours	4 hours	6 hours	6 hours	7 hours

(b) Fitters, Turners, Millwrights, Erectors

First Year	Second Year	Third Year	Fourth Year	Fifth Year
Machine Drawing, St. I. Geometry, St. I.	Mathematics Mach. Drawing, St. II. App. Mechanics, St. I.	Practical Mathematics, St. I. Mach. Drawing, St. II. App. Mechanics, St. I. Steam, St. I.	Mach. Drawing, St. II. App. Mechanics, St. II. Steam, St. II.	As above
4 hours	5 hours	5 hours	4 hours	7 hours

ORGANISED COURSES OF INSTRUCTION—*Continued*

(c) Moulders and Patternmakers

First Year	Second Year	Third Year	Fourth Year	Fifth Year
Mathematics Machine Drawing, St. I. Geometrical Drawing 6 hours	Machine Drawing, St. I. Geometry, St. I. 4 hours	Practical Mathematics Machine Drawing, St. I. App. Mechanics, St. I. Geometry, St. II. 6 hours	App Mechanics St. I. Steam, St I. Inorganic Chemistry, St. I. Metallurgy, St. I. 4 hours	Workshop Metallurgy, St. I. (Theo. and Pract.) Chemistry, St. I. (Theo. and Pract.) 7 hours

(d) Smiths and Boilermakers

First Year	Second Year	Third Year	Fourth Year	Fifth Year
Machine Drawing, St. I. Geometrical Drawing 4 hours	Machine Drawing, St. I. Geometry, St. I. Mathematics for Beginners 5 hours	Pract. Maths., St. I. App. Mechanics, St. I. Steam, St. I Sound, Light, and Heat Geometry, St. II. 6 hours	Applied Mechanics Steam Workshop 4 hours	Chemistry, St. I. (Theo. and Pract.) Metallurgy (Theo. and Pract.) 5 hours

NEWCASTLE-ON-TYNE—RUTHERFORD COLLEGE

First Year	Second Year	Third Year	Fourth Year	Fifth Year
Mathematics, St. I. Geometry, St. I. Machine Drawing, St. I.	Mathematics, St. II. Geometry, St. II. Mach. Drawing, St. II. App. Mechanics, St. I. Steam, St. I.	App. Mechanics, St. II. Steam, St. II. Mechanical Engineering (Ord. Grade)	App. Mechanics, St. III. Steam, St III. Mach. Drawing, St. III.	App. Mechanics (Hons.) Steam (Hons.)

ORGANISED COURSES OF INSTRUCTION—*Continued*

SALFORD

First Year	Second Year	Third Year	Fourth Year	Fifth Year
Workshop Arithmetic Preliminary Geometry Freehand Drawing	Preliminary Practical Mathematics Geometry, St. I. Preliminary Machine Drawing	Practical Mathematics Mach Drawing, St. I Geometry, St. II. Preliminary Applied Mechanics	Mach. Drawing, St. II. App Mechanics, St. I. (Theo. and Pract.) Steam, St. I. (Theo. and Pract.)	Practical Mathematics App. Mechanics, St. II. Steam. St. II. Graphics Machine Drawing, St. III. Sixth Year Practical Mathematics App. Mechanics, St. III. Steam, St. III. Machine Design (Hons.)
3 nights—5 hours	3 nights—6 hours	3 nights—7 hours		

II.—*Minor Mechanical Engineering Courses.*

In a number of schools it has been recognised that the standard of theoretical instruction aimed at in the general courses is too high for those from whom will be chosen the minor officials. Courses of instruction have therefore been drawn up in which Mechanics and Steam, for example, are not carried beyond the elementary stage, and the standard of mathematical knowledge has been similarly restricted so as to bring it within the needs and capacity of the average shop foreman. The theoretical training required by these men must of necessity be closely associated with the ordinary operations and processes of the workshop; practical instruction is therefore highly essential, and probably explains why the courses have so far been arranged only in connection with the larger institutions.

Engineering work, after the necessary drawings have been completed, passes in order through the pattern shop, foundry, or smiths' shop, fitting and turning, or boiler shop, in the order given. These represent, broadly, the divisions for which instruction may conveniently be arranged.

All courses, it will be noted, provide for the teaching of simple Mathematics and a fair amount of Geometrical Drawing, with Machine or other Drawing peculiar to the special branch of the trade. Some Applied Mechanics is also generally included. A point of interest is the essentially practical character of the instruction at Birmingham, which, however, does not appear to be progressive.

In connection with the instruction for special branches of the trade, it may be noted that the

courses at Bolton grouped in the major division really belong here. They are worthy of close attention because of the manifest attempt to give a broad basis of scientific knowledge without too much specialisation. At the same time, they do not include practical teaching in the workshop, and exception might be taken to the order of treatment on educational grounds.

In smaller towns a course of instruction of this type is really what is required. Only the larger towns, as a rule, can supply a sufficient number of men capable of following the general courses. It is somewhat unfortunate, therefore, that the more ambitious schemes are universal in smaller places, where, but for the absence of workshops—and probably workshop instructors also—the more modest scheme would be desirable. This question will be further discussed in Chapter IX.

MINOR MECHANICAL ENGINEERING COURSES

Pattern Making

First Year	Second Year	Third Year	Fourth Year	Fifth Year
PRESTON				
Workshop Arithmetic Geometry, St. I. Applied Mechanics, St. I.	Practical Mathematics Machine Drawing, St. I. Steam, St. I.	Mach. Drawing, St. II. App. Mechanics, St. II. Steam, St. II. Laboratory		
BOLTON—(Also for Moulders)				
Machine Drawing, St. I. Mathematics Geometrical Drawing 6 hours	Geometry, St. I. Mach. Drawing, St. I. 4 hours	Practical Mathematics App. Mechanics, St. I. Mach. Drawing, St. II. Geometry, St. II. 6 hours	App. Mechanics, St. I. Steam, St. I. Chemistry Metallurgy 4 hours	Workshop Chemistry, St. I. (Theo. and Pract.) Metallurgy, St. I. (Theo. and Pract.) 7 hours
SALFORD				
Workshop Arithmetic Preliminary Geometry Freehand (Optional) Workshop	Prelim. Pract. Maths. Geometry, St. I. Prelim. Mach. Drawing (Optional) Workshop	Mach Drawing, St. I. Geometry, St. II. Prelim. App. Mechs Elem. Pattern Making	Mach. Drawing, St. II. App. Mechanics, St. I. (Theo. and Pract.) Advanced Pattern Making	
BIRMINGHAM				
Pattern Shop Special Drawing or Lecture Course Algebra or Practical Mathematics Workshop Lecture Course	Apparently not progressive			

MINOR MECHANICAL ENGINEERING COURSES—*Continued*

Iron and Brass Founding

First Year	Second Year	Third Year	Fourth Year	Fifth Year
PRESTON				
Workshop Arithmetic Geometry, St. I. Chemistry, St. I.	Practical Mathematics App. Mechanics, St. I. Machine Drawing, St. I	App. Mechanics, St. II. Electricity, St. I. Steam, St. I. Mechanical Laboratory		
WEST HAM				
Mech. Engineering (Jun.) Chemistry (Jun.—Theo. and Practical) Foundry Shop Practice	Eng'ing Drawing (Jun.) Metallurgy Foundry Shop Practice	Lectures on Foundry Work (Jun.) Eng'ing Drawing (Inter.) Foundry Shop Practice	Lectures on Foundry Work (Senior) Engineering Laboratory (Testing Materials) Foundry Shop Practice	
BOLTON				
See Pattern Making				
BIRMINGHAM				
Arithmetic Special Drawing and Lecture Course Workshop Lecture Courses	Apparently not progressive			

MINOR MECHANICAL ENGINEERING COURSES—*Continued*

Mechanics

First Year	Second Year	Third Year	Fourth Year	Fifth Year
SHEFFIELD				
Machine Drawing Workshop	Practical Mathematics Applied Mechanics Workshop	Solid Geometry Machine Tool Lecture Workshop		
BOLTON				
Machine Drawing, St. I. Geometry, St. I.	Mathematics Machine Drawing App. Mechanics, St. I.	Practical Mathematics Mach. Drawing, St. II. App. Mechanics, St. I. Steam, St. I.	Mach. Drawing, St. II. App. Mechanics, St. II. Steam, St. II.	Workshop Electrical Engineering (Theo. and Pract.) Magnetism and Electricity (Theo.)
SALFORD				
Workshop Arithmetic Preliminary Geometry Preliminary Physics Freehand (Optional) Workshop	Prelim. Pract. Maths. Prelim. Mach. Drawing Geometry, St. I. (Optional) Workshop	Practical Mathematics Mach. Drawing, St. I. Prelim. App Mechanics		
BIRMINGHAM				
Algebra or Practical Mathematics Fitting and Turning Shop Special Geometry of Mechanical Drawing Workshop Lecture Course	Apparently not progressive			

MINOR MECHANICAL ENGINEERING COURSES—*Continued*

BOILERMAKERS

BOLTON—(ALSO FOR SMITHS)

First Year	Second Year	Third Year	Fourth Year	Fifth Year
Machine Drawing, St. I. Geometrical Drawing	Mathematics (for Beginners) Mach. Drawing, St. I Geometry, St. I.	Pract. Maths., St. I. App. Mechanics, St. I. Steam, St I. Sound, Light, and Heat Geometry, St. II.	Applied Mechanics Steam Workshop	Chemistry, St. I. (Theo. and Practical) Metallurgy, St. I. (Theo. and Practical)
4 hours	6 hours	6 hours	4 hours	5 hours

BIRMINGHAM—(ALSO FOR BRIDGE BUILDERS)

Practical Mathematics Special Geometrical and Mechanical Drawing Workshop Lecture Course	Apparently not progressive

METAL PLATE TRADES

LIVERPOOL

First Year	Second Year	Third Year	Extra Subjects Suggested	
Calculations for Engineers Prep. Pract. Mathematics	Metal Plate Work (Theo. and Pract., with Drawing., Ord.) Boilermakers' Work Geometrical Drawing	Hons. Metal Plate Work Also, if possible, Mathematics or Practical Geometry	Machine Drawing Mathematics Theoretical Mechanics Sound, Light, and Heat	Magnetism and Electricity Chemistry Freehand

III.—*General Courses in Electrical Engineering.*

The following table shows the number of courses in which the principal subjects are prescribed, and their duration:

Subject	One Year	Two Years	Three Years	Four Years	Five Years
Mathematics,	—	2	9	4	—
Geometry,	3	1	—	—	—
Machine Drawing,	3	5	3	—	—
Applied Mechanics,	7	5	1	—	—
Steam,	4	5	—	—	—
Electricity & Magnetism,	6	6	—	—	—
Electric Light & Power,	2	4	5	2	1
Sound, Light, & Heat,	3	1	—	—	—
Heat,	1	—	—	—	—
Chemistry,	4	—	—	—	—

This table is an analysis of fifteen courses, as against twenty-six in Mechanical Engineering. It will be noted that there is rather more uniformity as to the number of years of study to be given to Mathematics. The conclusion to be drawn is that Mathematics is considered of more importance in Electrical than in Mechanical Engineering. It is interesting to note that ten of the fifteen courses prescribe Practical rather than Pure Mathematics. Geometry does not appear to be regarded as an essential subject, and it is somewhat surprising to find that only four courses include this subject, while eleven propose Machine Drawing.

Electrical Engineering is commonly said to consist of two-thirds Mechanical Engineering and one-third

Applied Physics, and that this view is general is borne out by the attention given to Machine Drawing, Applied Mechanics, and Steam.

Electricity and Magnetism is recommended for one or two years in all but three of the courses; those three—Bradford, West Ham, and Salford—start right away with the more practical subject. The educational value of this branch of Physics, considered alone, is doubtful; its connection with Dynamics, Heat, and Light is so close that some general knowledge of Physics is essential. Yet only four courses provide for this.

One other matter deserves notice. While in the Mechanical Engineering courses only three out of twenty-six include Chemistry, in the younger industry four out of fifteen contain it. In which industry is a knowledge of Chemistry in its relation to the property of materials of greater importance, and in any case would the above figures express the relative importance? Electro-metallurgy is not taken into account, as for it special courses are provided.

IV.—*Minor Electrical Engineering Courses.*

The only Minor Electrical Industry that need be mentioned is Electrical Wiring and Fitting. Three courses are given, and there is a general similarity as to grouping and order of subjects. Some knowledge of Elementary Physics and Chemistry, similar to that usually given to plumbers, might be thought desirable.

ELECTRICAL ENGINEERING

Three Year Courses

BRADFORD

First Year	Second Year	Third Year
Mathematics Physics Draughtsmanship Workshop 4 nights	Mathematics Physics Draughtsmanship Applied Mechanics Steam Electrical Engineering (Theo. and Pract.) Telegraphy and Telephony Workshop 5 nights	Mathematics Draughtsmanship Engine Testing Electrical Engineering Telegraphy and Telephony Workshop 4 nights

WOOLWICH POLYTECHNIC

First Year	Second Year	Third Year
F Electricity and Magnetism, St. I. (Theo. and Pract.) Mathematics, St. I. or II. Mechanical Engineering (Ordinary) Experimental Mechanics, or Machine Drawing *G* Electricity and Magnetism, St. I. (Theo. and Pract.) Mathematics, St. I. or II. Sound, Light, and Heat Machine Drawing	Electrotechnics (Theo. and Pract.) Mathematics, St. III. Applied Mechanics, St. II., or Electricity and Magnetism, St. II.	Electrotechnics (Hons.) (Theo. and Pract.) Mathematics, St. V. or VI. Engineering Laboratory Machine Drawing (Hons.)

ELECTRICAL ENGINEERING—*Continued*

First Year	Second Year	Third Year
BIRMINGHAM		
Algebra and Geometry, or Practical Mathematics Geometry and Mechanical Drawing Electricity, St. I. } With Laboratory Electrical Engineering } Work	Mathematics, St. II Applied Mechanics (Theo. and Pract.) Machine Drawing, St. II. Special Elect. Course) Electricity, St. II. (Inter. & Advanced) } Lectures and Electrical Engineering } Laboratory Work.	Practical Mathematics Electrical Engineering (Senior) (Courses *A* and *B*) Electrical Engineering (Design) Electrical Engineering (Laboratory)
PEOPLE'S PALACE, LONDON		
Mathematics, St. I. or II., or Electricity and Magnetism, St. I. Elementary Electrical Engineering Practical Mathematics or Steam, St. II. 3 nights	Electricity and Magnetism, St. II. Electrical Engineering (Advanced) Mathematics, St. II., III., or V. Steam, St. II. 4 nights	Mathematics, St. V. Electrical Engineering (Hons.)
BLACKBURN		
Magnetism and Electricity, St. I., with 1 or 2 of the following:— Mathematics Inorganic Chemistry Machine Drawing	Elementary Electrical Engineering, and 1 or more of subjects mentioned in first year	Electrical Engineering (Advanced), with 1 or 2 of following:— Electricity and Magnetism, St. II. Practical Mathematics, St. II. Applied Mechanics Steam

ELECTRICAL ENGINEERING—*Continued*

PRESTON—HARRIS INSTITUTE

First Year	Second Year	Third Year
Workshop Arithmetic Electricity and Magnetism, St. I. Applied Mechanics, St. I.	Practical Mathematics, St. I. Electricity and Magnetism, St. II. Machine Drawing, St. I. Steam, St. I.	Mathematics Electrical Engineering (Theo. and Pract.) Heat

KEIGHLEY

First Year	Second Year	Third Year
Practical Mathematics Geometry Machine Drawing Applied Mechanics Electricity and Magnetism	Practical Mathematics, etc., as in first year	Machine Drawing Applied Mechanics Electric Light and Power

DARLINGTON

First Year	Second Year	Third Year
Mathematics (Practical) Electricity and Magnetism (Theo. and Pract.) Chemistry (Theoretical)	Mathematics (Practical) Machine Drawing Electric Light and Power	Mathematics (Practical) Applied Mechanics Electric Light and Power

ELECTRICAL ENGINEERING—*Continued*

Four Year Courses

HUDDERSFIELD

First Year	Second Year	Third Year	Fourth Year
Practical Mathematics, St. I. Machine Drawing, St. I. Applied Mechanics, St. I. (Theo. and Pract.) Electricity and Magnetism, St. I.	Practical Mathematics, St. II. Machine Drawing, St. II. Applied Mechanics, St. II. (Theo. and Pract.) Electrical Engineering, St. I. Practical Electricity, St. I.	Practical Mathematics, St. II. Steam, St. I. Electrical Engineering, St. II. Practical Electricity, St. II.	Electricity and Magnetism, St. II. Steam, St. II. Electrical Engineering, St. III. Practical Electricity Sound, Light, and Heat

WEST HAM

First Year	Second Year	Third Year	Fourth Year
Mathematics (Inter.) Engineering Drawing (Junior) Electrical Engineering (Junior)	Mechanical Engineering (Jun.) Electrical Engineering (Inter.) Engineering Drawing (Inter.)	Electrical Engineering (Inter. *B*) Mechanical Engineering (Inter. *B*) Mathematics (Senior *A*)	Electrical Engineering (Senior) Mechanical Engineering (Senior *B*) Electrical Design

WEST HARTLEPOOL

First Year	Second Year	Third Year	Fourth Year
Practical Mathematics, St. I. Geometry, St. I. Electricity and Magnetism, St. I.	Practical Mathematics Electricity and Magnetism, St. II. Applied Mechanics, St. I. Chemistry, St. I.	Mathematics, St. II. Applied Mechanics, St. II. Electric Light and Power	Mathematics, St. II. Steam, St. I. or II. Electric Light and Power

ELECTRICAL ENGINEERING—*Continued*

Five Year Courses

First Year	Second Year	Third Year	Fourth Year	Fifth Year
MANCHESTER				
Practical Mathematics Machine Drawing Electricity and Magnetism, St. I. (Theo. and Pract.)	Practical Mathematics Electrical Engineering (Theo. and Pract.) Mechanics Steam	Practical Mathematics, etc., as in second year	Electrical Engineering (Theo. and Pract.) Electrical Design	Alternating Currents Electrical Laboratory Electrical Design, or Steam Engine Laboratory
BRISTOL				
Practical Mathematics, St. I. Electricity and Magnetism, St. I. (Theo. and Pract.)	Practical Mathematics Chemistry, St. I. (Theo. and Pract.) Practical Wiring Class	Practical Mathematics, St. II. Electricity & Magnetism, St. II. (Theo. & Pract.) Applied Mechanics, St. I. (Theo. and Pract.)	Practical Mathematics, St. II. Machine Drawing, St I. Electrotechnics (Ord.) (Theo. and Pract.)	Machine Drawing, St. II. Steam, St. I. Electrotechnics (Hons.) (Theo. and Pract.) Sixth Year Higher Mathematics Electrotechnics (Pract.) Applied Mechanics, St. II. (Theo. and Pract.)
SALFORD				
Workshop Arithmetic Preliminary Electric Light Preliminary Physics Preliminary Geometry	Practical Mathematics Electric Lighting Preliminary Machine Drawing	Practical Mathematics Electric Lighting (Ord.) Machine Drawing, St. I. Prelim. App. Mechanics	Practical Mathematics Electric Lighting (Hons.) Electrical Design Machine Drawing, St. II.	Applied Mechanics, St. I. Steam, St. I. Elect. Engin. (Labor.) Elect. Engin. (Special)

ELECTRICAL WIRING

Three Year Courses

First Year	Second Year	Third Year
MANCHESTER		
Mathematics Geometry Magnetism and Electricity	Wiring Lecture and Calculations, with Practical Work Electrical Engineering (Lecture and Laboratory)	Electrical Engineering Lecture and Calculations Electrical Laboratory Practical Wiring
BIRMINGHAM		
Arithmetic Preliminary Electrical Engineering Lecture Electrical Jointing	Algebra or Practical Mathematics Electrical Engineering Lecture (Inter.) Electrical Jointing, St. II.	Electricity. St. II. Electrical Engineering (Advanced) Electrical Jointing, St. III.
SALFORD		
Workshop Arithmetic Electric Lighting, St. I. Electric Wiring, St. I.	Practical Mathematics Electric Lighting, St. II. Electric Wiring, St. II.	

V.—*Major Courses in Building.*

The following table gives, as in previous cases, the number of courses which devote 1, 2, 3, 4 and 5 years to the chief subjects:

Subjects	One Year	Two Years	Three Years	Four Years	Five Years
Mathematics,	2	8	2	1	—
Geometry,	4	5	1	—	—
Building Construction,	—	1	6	5	1
Applied Mechanics,	4	3	—	—	—
Graphic Statics,	2	2	—	—	—
Theoretical Mechanics,	2	2	—	—	—
Physics, Chemistry, or General Elem. Science,	1	1	—	—	—

There is a general agreement here that Mathematics and Geometry are, up to a certain point, essential. Eight courses out of the thirteen considered give preference to Practical over Pure Mathematics. In regard to Geometry, it may be noted that this subject is included in the preliminary, but not the general, course at St. Helens. The only two which ignore it are West Ham and Liverpool; but apart from the courses, students who propose to attend the class in Building Construction at these places must show that they possess a knowledge of Drawing, and suitable preliminary courses are provided either at the Technical or the Continuation Schools.

The introduction of the Mechanics of Structures into the Building Construction syllabus a few years ago has necessitated provision for instruction in this

part of the subject. Of the seven courses which involve Applied Mechanics, two also include Graphic Statics. Thus nine of the thirteen courses contain one or other of these subjects, and two others make a similar provision by prescribing Theoretical Mechanics.

One course—Preston—includes Hygiene, and in a number of places the student is advised to join the City and Guilds of London Institute Class in his own branch of the trade, *e.g.*, Carpentry and Joinery, Brickwork, Masonry, Plumbing, etc. In the larger centres, instruction in Builders' Quantities and Architectural Design find places.

There is less tendency in this than in either of the groups of general courses already considered, to regard instruction in Chemistry and Physics as essential. To the two which are noted in the table may be added St. Helens, which provides instruction in General Elementary Science in the Compulsory Preliminary Course. Some effort in this direction is also made at Liverpool, where the class in that subject is free to those attending other classes.

MAJOR COURSES IN BUILDING

Three Year Courses

First Year	Second Year	Third Year
	ST. HELENS	
Practical Mathematics Theoretical Mechanics Building Construction	Practical Mathematics Building Construction	Building Construction
	DERBY	
Mathematics Geometrical Drawing Building Construction	Mathematics Graphics Practical Geometry Building Construction	More advanced work in second year subjects, with Lecture on Carpentry and Joinery, and Brickwork and Masonry
	PEOPLE'S PALACE, LONDON	
Mathematics, St. I. Geometry, St. I. Building Construction, St. I	Mathematics Theoretical Mechanics Applied Mechanics Geometry Building Construction, St. II.	Mathematics Theoretical Mechanics Building Construction
	STOCKPORT	
Practical Mathematics Building Construction Carpentry or Brickwork	Geometry Building Construction, St. II Carpentry or Brickwork	Geometry Building Construction Applied Mechanics

MAJOR COURSES IN BUILDING—*Continued*

PRESTON

First Year	Second Year	Third Year
Workshop Arithmetic Plane and Solid Geometry Building Construction, St. I.	Mathematics, St I., or Geometry, St II. Building Construction, St. II. Brickwork and Masonry	Building Construction (Hons.) Carpentry and Joinery Hygiene, St. I.

WEST HARTLEPOOL

First Year	Second Year	Third Year
Practical Mathematics Geometry, St. I. Building Construction, St. I.	Practical Mathematics Applied Mechanics Building Construction, St. I. Carpentry and Joinery, or Plumbing	Building Construction, St II. Geometry, St. II. Applied Mechanics, St. II , or Plumbing

Four Year Courses

WEST HAM

First Year	Second Year	Third Year	Fourth Year
Mathematics (Inter. *A.*) Mechanical Engineering (Jun.) Building Construction	Building Construction (Inter.) Workshop Class for Special Trade	Building Construction (Inter. or Sen.) Builders' Quantities Architectural Design or Art Class Surveying (Summer)	Building Construction (Sen.) Builders' Quantities (Sen.) Architectural Design

MAJOR COURSES IN BUILDING—*Continued*

BIRMINGHAM

First Year	Second Year	Third Year	Fourth Year
Practical Mathematics Practical Geometry Applied Mechanics, St. I.	Building Construction, St. I. 2 nights Applied Mechanics, St. II.	Building Construction, St. II Builders' Quantities (Ord. Grade) Graphic Statics	Practical Mathematics Building Construction (Hons.) Structural Design (Special) Materials and Processes of Construction

BRIGHTON

First Year	Second Year	Third Year	Fourth Year
Mensuration or Practical Mathematics General Elementary Science Practical Geometry Building Construction	Mensuration or Practical Mathematics Practical Geometry Principles of Mechanics Building Construction	Graphic Statics Practical Geometry Building Construction	Building Construction Architectural Design Sanitary Engineering Quantity Surveying Surveying

DARLINGTON

First Year	Second Year	Third Year	Fourth Year
Mathematics Geometry Building Construction, St. I.	Practical Mathematics Building Construction, St. I. Graphic Statics Applied Mechanics Drawing Practice	Building Construction, St. II. Builders' Quantities Graphic Statics Applied Mechanics Drawing Practice Architectural Design	Building Construction Builders' Quantities Statics Architectural Design

MAJOR COURSES IN BUILDING—*Continued*

Five Year Courses

First Year	Second Year	Third Year	Fourth Year	Fifth Year
LIVERPOOL				
Calculations for Builders Building Construction (First Year's Course) Preparatory Practical Mechanics	Preliminary Grade in Student's own Trade Mathematics Applied Mechanics *Optional* Building Construction, St. I. Practical Class in Trade Subject	Mathematics, St. I., or Practical Building Construction, St. I. Ordinary Grade of Student's own Trade *Optional* Practical Class in Trade Subject One other subject	Building Construction, St. I. Honours Grade in Students' own Trade Practical Class in Trade Subject, or Builders' Quantities	Hons. Building Construction, or other subjects
NEWCASTLE-ON-TYNE—RUTHERFORD COLLEGE				
Mathematics, St. I, Practical Geometry, St. I.	Mathematics, St. I. Geology, St. I. Physics, St. I. Building Construction, St. I.	Mathematics Theo. Mechanics, St. I. Chemistry, St. I. (Theoretical and Practical) Building Co .str., St. II.	Mathematics Architecture Building Construction, St. III.	Architecture Building Construction, (Hons.)
KEIGHLEY				
Practical Mathematics Building Construction Geometry Woodwork } (Optional) Masonry } (Optional) Turning } (Optional)	Practical Mathematics Geometry Building Construction *Optional* Subjects as before	Geometry Building Construction *Optional* Subjects as before	As in third year	Building Construction

VI.—*Minor Courses in Building.*

The recommendation in some of the General Courses to attend the City and Guilds subject bearing on the student's own branch of the trade is in most cases considered a sufficient concession to specialisation. A few schools have, however, drawn up special courses, in which, while a general knowledge of the principles underlying the whole trade are kept in view, the curriculum aims at giving the student the highest possible knowledge of his own particular division.

The two courses in Carpentry and Joinery call for little comment. They are very similar, the extra year required for the Salford course being balanced by the Compulsory Preliminary Course at St. Helens.

The courses in Sanitary Science contain no particular point to which attention need be drawn, unless it is the tendency to over-weight them in the first year.

The courses in Plumbing possess some points of interest. It is not quite clear, for example, why Theoretical Mechanics is necessary for this trade, especially as Solids is chosen. The Fluids Section would be quite appropriate. However, in all these cases, as will be clear later, regard must be had to the organisation of the school, and if the exact subject required to fit any particular trade cannot be arranged for, the nearest one must be substituted. At St. Helens, Practical Mathematics and Theoretical Mechanics are taken together, and are common to all the courses.

In most places it is customary to leave instruction

in Elementary Physics and Chemistry to the teacher of Plumbing. The small amount of instruction that can be given in these subjects under the circumstances is supplemented by additional classes in the courses at Preston, Manchester, and Bristol. The second year's course at Manchester is rather heavy; if Mechanics and Physics replaced workshop instruction, a better balance would be obtained. The Bristol course is remarkable as including Physiology and excluding Physics.

There is a greater desire manifested in these Plumbing courses to include the Physical Science underlying the practice, than in the courses for any handicraft that have yet been considered.

MINOR COURSES IN BUILDING

Carpenters and Joiners

SALFORD

First Year	Second Year	Third Year
Workshop Arithmetic Freehand Drawing Workshop Drawing, including Building Construction (Optional) Workshop	Preliminary Practical Mathematics Preliminary Geometry Preliminary Carpentry (Optional) Workshop	Practical Mathematics, St. I. Geometry, St. I. Carpentry (Ord. Grade) (Optional) Workshop Fourth Year Practical Mathematics Carpentry (Hons.) Builders' Mechanics (Optional) Workshop

ST. HELENS

Practical Mathematics Theoretical Mechanics Building Construction Carpentry and Joinery (Theo. and Pract.)	Practical Mathematics Carpentry and Joinery (Theo. and Pract.)	Preparation for Hons. Grade, City and Guilds

MINOR COURSES IN BUILDING—*Continued*

SANITARY SCIENCE

MANCHESTER

First Year	Second Year	Third Year
Mathematics Chemistry Physics Hygiene	Sanitary Inspection Lectures Hygiene Drawing	Laboratory Exercises in Sanitation Drawing

BRADFORD

Arithmetic Physics Chemistry Plumbing Building Construction	Mechanical Drawing Sanitary Laws, etc. Sanitary Engineering	

MINOR COURSES IN BUILDING—*Continued*

Plumbing

First Year	Second Year	Third Year	Fourth Year	Fifth Year
ST. HELENS—GAMBLE INSTITUTE				
Practical Mathematics Theoretical Mechanics Plumbing (Theo. and Pract.)	Practical Mathematics Building Construction Plumbing (Theo. and Pract.)	Preparation for Hons Examination in Plumbing, C. & G. I.		
PRESTON—HARRIS INSTITUTE				
Workshop Arithmetic Geometry, St. I. Hygiene, St. I.	Heat, St I Plumbing Building Constr., St I	Building Constr., St. II. Plumbing Hygiene, St II. Theoretical Chemistry		
MANCHESTER				
Mathematics Chemistry Drawing Workshop	Mathematics Chemistry Drawing Plumbing (Theo and Pract.) Mechanics and Physics	Drawing Plumbing (Theo and Pract.)	As in third year	Drawing Practical Plumbing Testing Materials
BRISTOL				
Practical Mathematics Geometry, St. I. Chemistry, St I. (Theo and Pract.)	Geometry, St I Building Constr., St. I. Plumbing (Ord.) (Theo. and Pract.)	Physiology, St. I Building Construction, St II. Plumbing (Ord.)	Elem Laws of Health App. Mechanics (Theo and Pract.) Plumbing (Hons.), or Builders' Quants. (Ord).	Advd. Laws of Health App. Mechanics, St. II. (Theo. and Pract.) Plumbing (Hons.), or Builders' Quants. (Hons.)

VII.—*Courses in Mining.*

The Miner calls so many natural forces into play in the exercise of his calling that breadth of basis must be looked for in any course of instruction adapted to his requirements. These courses are not as numerous as one might expect even in districts situated over the large coalfields. Five are given on pages 148-9.

The Sheffield courses are held at Derby on Saturday afternoons. Machine Drawing and Mine Surveying are taught in alternate years. The omission of Mathematics is remarkable. The courses are, with one exception, in agreement in requiring the student to devote considerable attention to the Engineering subjects, as well as to Mining proper, and the question whether the steam engine user requires the same kind of instruction as the steam engine maker may be passed over here. Three of the five include Chemistry—obviously with a view to enabling the student to understand what he reads as to the composition of rocks, explosions, and the gases of the mine. Is the Physics usually included in a course on Chemistry sufficient for him to understand those parts of Mining which find their explanation in that science? Apparently it is generally thought to be so, for the subject is not definitely included except in one course, and then by a sudden jump from nowhere into the advanced stage of Heat. The omission of Physics is general in most of the courses examined, and the importance of the subject will be discussed in Chapter VII.

In the Nottingham scheme the science of Mining includes General Physics, Mechanics, Heat, the Steam Engine, Electricity and Electrical Engineering. The Durham scheme is not at all unlike this, but partakes more of the University Extension type of instruction. Each lecture is of fifty minutes' duration, and is carried on for a term. The curriculum in each of these schemes is fairly well balanced, but it looks as though the knowledge gained might be a little superficial. The absence of Mathematics at Nottingham and Drawing at Durham are defects.

Mining is one of the few industries in which the Manager must possess a certificate. The Coal Mines Regulation Act requires that Colliery Managers and Under Managers should possess the 1st or 2nd Class Certificates respectively, and Boards of Examiners have been established by statute to hold periodical examinations upon the results of which certificates of competency are awarded. The object is not, of course, to supply capable Mining Engineers with a Diploma, but to ensure the least possible danger to life and limb by requiring that those in charge shall have a knowledge of colliery working in accordance with the Act. The standard varies a good deal between district and district, and so far but little success has attended efforts at securing uniformity of standard. Any scheme of Technical Education for coal miners must include instruction for the Home Office Certificate, as it is called, within the scope of its operations.

COURSES IN MINING

SHEFFIELD—(Held at Derby under Direction of University College, Sheffield)

First Year	Second Year	Third Year
Mechanics and Chemistry Mining Steam Machine Drawing, or Mine Surveying	Mining Steam Machine Drawing, or Mine Surveying	
ST. HELENS		
Practical Mathematics Theoretical Mechanics Applied Mechanics Steam Mining	Practical Mathematics Applied Mechanics Steam Mining	Not finally settled
SWANSEA—(A) Engineering Section		
Mathematics, St. I. Geometry, St. I. Mining, St. I. Applied Mechanics, St. I. Chemistry, St. I. (Theo. and Pract.)	Mathematics, St. II. Machine Drawing, St. I. Mining, St. II. Applied Mechanics, St. I. Steam, St. I.	Machine Construction, St. II. Mining (Hons.) Applied Mechanics, St. II. Steam, St. II. Heat, St. II., or Electricity and Magnetism, St. I.

COURSES IN MINING—*Continued*

SWANSEA—(*B*) SURVEYING SECTION		
Mathematics, St. I. Geometry, St. I. Mining, St. I. Theoretical Mechanics, St. I. Chemistry, St. I. (Theo. and Pract.)	Mathematics, St. II. Geometry, St. II. Mine Surveying (Ord.)	Mathematics, St. III. Geometry, St. II. (or Hons) Geology, St. II. (or Hons.) Mine Surveying (Hons.)
NEWCASTLE-ON-TYNE—RUTHERFORD COLLEGE		
Mathematics, St. I. Geology, St. I. Mining, St. I.	Mathematics Preliminary Surveying Mining, St. II.	Surveying (Ord.) Mining, St. III. Fourth Year Surveying (Hons.) Mining (Hons.)
NOTTINGHAM—UNIVERSITY COLLEGE		
Elementary Science Engineering Drawing Mining Saturday—3½ hours	Science of Mining Surveying Mining Saturday—3½ hours	Science of Mining Surveying Mining Saturday—3½ hours
NEWCASTLE-ON-TYNE—DURHAM COLLEGE OF SCIENCE		
Mensuration Chemistry of Fuel Boring and Shaft Sinking } 1st term Geology Mechanics Drifts and Levels } 2nd term Saturday—3 hours	Geology of the Coalfields Theoretical Electricity Exploitation of Mines Chemistry of Mine Gases and Explosives The Steam Engine Haulage and Winding Saturday—3 hours	Geometry Transmission of Power Pumping and Ventilation Trigonometry Mine Surveying Management of Horses Saturday—3 hours

VIII.—*Courses in Metallurgy.*

Of the four courses given on page 151, those of St. Helens and Longton deal with the subject purely from the chemical side. They provide a fairly satisfactory course of study for those engaged in Metallurgical Laboratories. The Longton course insists on a fairly extensive knowledge of Inorganic Chemistry, but ignores any lack of Mathematical knowledge. On the other hand, the St. Helens course does not pursue Chemistry further than the Elementary stage, but involves two years at Practical Mathematics. They are alike in failing to regard Physics as essential, and in making no provision for instruction in it. The amount of knowledge of this subject required for the daily operations of the Metallurgical Chemist is probably not great, but modern progress cannot be followed without a good grasp of the fundamental principles of Heat and Electricity.

The Manchester course treats the whole subject more from the point of view of the Works Manager than from that of the Chemist. The only points which invite comment are the single year devoted to Physics and the three years' course in Mineralogy.

The Swansea course recognises the importance of both Chemistry and Engineering, cuts down the essentials of Physics to one year at Electricity and Magnetism, and apparently regards Mathematics as unnecessary.

COURSES IN METALLURGY

First Year	Second Year	Third Year	Fourth Year	Fifth Year
ST. HELENS—GAMBLE INSTITUTE				
Practical Mathematics Theoretical Mechanics Inorganic Chemistry (Theo. and Pract.) Metallurgy (Theo. and Pract.)	Pract. Mathematics Metallurgy (Theo. and Pract.)	Metallurgy (Theo. and Pract.)		
SWANSEA				
Geometry, St. I., or Machine Drawing, St. I. Applied Mechanics, St. I. Chemistry, St. I. (Theo. and Pract.) Metallurgy, St. I. (Theo. and Pract.)	Mach. Constr., St. I, or Building Constr., St. I. App. Mechanics, St. II. Mag. and Elect., St. I. Chemistry, St. I. (Theo. and Pract.) Metallurgy, St. II. (Theo. and Pract.)	Machine Construction, St. I., or St. II. Chemistry (Hons.) (Theo. or Pract.) Metallurgy (Hons.) (Theo. and Pract.) Iron and Steel, or Metallurgy of Copper		
LONGTON—STAFFORDSHIRE				
Chemistry, St. I. (Theo. and Pract.) Metallurgy, St. I. (Theo. and Pract.)	Chemistry, St. II. (Theo. and Pract.) Metallurgy, St. II. (Theo. and Pract.) Iron and Steel (Ord.)	Chemistry, St. III (Theo. and Pract.) Metallurgy St. III. (Theo. and Pract.) Iron and Steel (Hons.)	Chemistry (Hons.) (Theo and Pract.) Metallurgy (Hons.) (Theo. and Pract.)	
MANCHESTER				
Mathematics Physics Chemistry	Chemistry Machine Drawing Metallurgy	Mineralogy Metallurgy Mechanics Steam	Mineralogy Metallurgy Engineering Laboratory Descriptive Engineering	Mineralogy Metallurgy Applied Electricity Electro-Metallurgy

Some interesting courses have been drawn up by the County Council of the West Riding of Yorkshire, to be followed by holders of Technical Exhibitions (see p. 203). They require that on not less than two nor more than three evenings per week, not less than two nor more than four subjects be taken in any one year. The Junior Courses are intended for students between fourteen and sixteen years of age; the Senior for those over sixteen. The scheme is intended to be suggestive rather than definite, and as will be indicated later, in some cases the elasticity destroys the benefit which it is hoped to reap from prescribed curricula.

One of the most satisfactory features is the insistence upon an adequate preliminary training; in no case is an applied subject compulsory in the Junior Course. The sentiment that permits a student to waste his time at a subject for which, though bearing closely upon his occupation, he has had no suitable preparation, is evidently less prevalent in Yorkshire than in most other counties. There are districts where the return on public expenditure is less closely safeguarded.

The Junior Schemes involve thorough preparatory training in Mathematics and Drawing. The elements of Physical Science is always an optional subject, and is probably frequently taken.

The introduction of Woodwork and Metal Work is worth attention. There are always students who, while capable of a certain amount of theoretical study, have their limitations in this respect, and yet possess more than ordinary manual dexterity. Such students will probably do well to follow the workshop

courses offered, for though the need of skilled labour is rapidly dying out in most industries in which machinery has been introduced, the necessity for clever craftsmen here and there still exists.

The elasticity of curricula, as has already been remarked, is a disadvantage. The view that it may be due to the desire to cater for special branches of the main trade is not borne out on closer inspection. A more reasonable explanation would be that the limitations due to the staff, etc., of recognised schools makes alternatives imperative, the exhibitions being tenable at one or other of some forty centres of instruction. But whatever the cause, the alternatives provide ample scope for irrational order and discontinuity to creep in.

COURSES SUGGESTED BY YORKSHIRE (W. R.) COUNTY COUNCIL

Mechanical Engineering

JUNIOR

First Year	Second Year	Third Year
Compulsory (a) Practical Geometry (b) Technical Arithmetic, or Mathematics *Optional* Laboratory Work in Elementary Physics Theoretical Mechanics Freehand and Model, or Technical Sketching	*Compulsory* (a) Practical Geometry (b) Mathematics, or Practical Mathematics *Optional* As in first year	*Compulsory* (a) Practical Geometry (b) Mathematics, or Practical Mathematics *Optional* As for first year Woodwork, or Machine Drawing

SENIOR

Compulsory (a) Practical Geometry, or Mathematics (b) Machine Drawing *Optional* The other subject under (a) Laboratory Work in Physics, or Woodwork	*Compulsory* (a) As for first year, or Theoretical Mechanics (b) Machine Drawing *Optional* Another subject under (a) Applied Mechanics, or Steam	*Compulsory* (a) Machine Drawing (b) Applied Mechanics, or Steam, or Mechanical Engineering *Optional* Theoretical Mechanics, Metal Work, Engineering Laboratory, or other subject under (b)

COURSES SUGGESTED BY YORKSHIRE (W. R.) COUNTY COUNCIL—*Continued*

ELECTRICAL ENGINEERING

JUNIOR

First Year	Second Year	Third Year
Compulsory (*a*) Practical Geometry (*b*) Technical Arithmetic, or Mathematics *Optional* Laboratory Work in Physics Theoretical Mechanics Freehand and Model, or Technical Sketching	*Compulsory* (*a*) Practical Geometry (*b*) Mathematics, or Practical Mathematics *Optional* As for first year	*Compulsory* (*a*) Practical Geometry (*b*) Mathematics, or Practical Mathematics *Optional* As for first year Machine Drawing Magnetism and Electricity, or Woodwork

SENIOR

First Year	Second Year	Third Year
Compulsory (*a*) Practical Geometry, or Mathematics (*b*) Machine Drawing *Optional* Other subject under (*a*) Laboratory Work in Physics Theoretical Mechanics Magnetism and Electricity, or Woodwork	*Compulsory* (*a*) As for first year, or Theoretical Mechanics (*b*) Magnetism and Electricity *Optional* Other subject under (*a*) Machine Drawing Chemistry Woodwork, or Metal Work	*Compulsory* (*a*) Mathematics, or Theoretical Mechanics, or Applied Mechanics (*b*) Magnetism and Electricity *Optional* Chemistry Electric Light and Power Telegraphy and Telephony, or Metal Work

COURSES SUGGESTED BY YORKSHIRE (W. R.) COUNTY COUNCIL—*Continued*

BUILDING

JUNIOR

First Year	Second Year	Third Year
Compulsory (*a*) Practical Geometry (*b*) Technical Arithmetic, or Mathematics *Optional* As in Mechanical Engineering	*Compulsory* (*a*) Practical Geometry (*b*) Mathematics, or Practical Mathematics *Optional* As in Mechanical Engineering	*Compulsory* (*a*) Practical Geometry (*b*) Mathematics, or Practical Mathematics *Optional* As for first year, or Woodwork

SENIOR

Compulsory (*a*) Practical Geometry, or Mathematics (*b*) Building Construction *Optional* The other subject under (*a*) Hygiene Brickwork Masonry Carpentry and Joinery, or Woodwork	*Compulsory* As for first year *Optional* As in first year	*Compulsory* (*a*) Building Construction (*b*) Theoretical or Applied Mechanics *Optional* Brickwork Masonry Carpentry and Joinery Engineering Laboratory

COURSES SUGGESTED BY YORKSHIRE (W. R.) COUNTY COUNCIL—*Continued*

PLUMBING

	First Year	Second Year	Third Year
JUNIOR	*Compulsory* (a) Practical Geometry (b) Technical Arithmetic, or Mathematics	*Compulsory* (a) Practical Geometry (b) Mathematics, or Practical Mathematics	*Compulsory* (a) Practical Geometry, or Chemistry (b) Mathematics, or Practical Mathematics
	Optional As in Engineering, except Theoretical Mechanics	*Optional* As in first year	*Optional* Laboratory Work in Hydrostatics and Heat, or Building Construction Chemistry, or Woodwork
SENIOR	*Compulsory* (a) Practical Geometry, or Mathematics (b) Building Construction, or Theoretical Mechanics, or Heat, or Laboratory Work in Hydrostatics and Heat, or Chemistry	*Compulsory* (a) As in first year, or Theoretical Mechanics (b) The other subject under (a), or as for first year	*Compulsory* (a) One subject under (a) or (b) for first year. (b) Plumbers' Work (Theo. and Pract.)
	Optional Hygiene Plumbing Theory	*Optional* Plumbing (Theoretical and Practical)	*Optional* One of the remaining subjects

COURSES SUGGESTED BY YORKSHIRE (W. R.) COUNTY COUNCIL—*Continued*

MINING:

JUNIOR

First Year	Second Year	Third Year
Compulsory (a) Practical Geometry (b) Technical Arithmetic, or Mathematics *Optional* As for Engineering, without Theo. Mechanics	*Compulsory* (a) Practical Geometry (b) Mathematics, or Practical Mathematics *Optional* As in first year, or Alternative Elementary Physics, or Alternative Elementary Chemistry	*Compulsory* (a) Practical Geometry, or Machine Drawing (b) Geology *Optional* The Other Subject under (a), or As for first year

SENIOR

First Year	Second Year	Third Year
Compulsory (a) Chemistry, or Geology, or Machine Drawing, or Mathematics (b) Mining, or Steam *Optional* One other subject under (a) or (b), or for Surveyors, Practical Geometry	*Compulsory* As for first year *Optional* As for first year	*Compulsory* (a) Mathematics, or Mechanics, or Practical Geometry (b) Mining *Optional* As for first year, or Mine Surveying

COURSES SUGGESTED BY YORKSHIRE (W. R.) COUNTY COUNCIL—*Continued*

CHEMICAL INDUSTRIES

	First Year	Second Year	Third Year
JUNIOR			
Compulsory	(a) Arithmetic, or Mathematics (b) Freehand and Model, or Technical Sketching	(a) Mathematics (b) Sound, Light and Heat, or Magnetism and Electricity, or Alternative Physics, with Laboratory Work	(a) Mathematics, or Practical Physics (b) Inorganic Chemistry (Theo. and Pract.)
Optional	Laboratory Work in Mechanics and Heat, or Sound, Light, and Heat	Inorganic Chemistry, or Alternative Chemistry, with Practical Work	As (b) for second year
SENIOR			
Compulsory	(a) Inorganic Chemistry (Theo. and Pract.) (b) Mathematics, or Practical Physics, or Theo. and Pract. Metallurgy, or Oils and Fats, or Dyeing, etc.	(a) Inorganic Chemistry (Theo. and Pract.) (b) Organic Chemistry, or Metallurgy, or Dyeing (Theo. and Pract.)	(a) Inorganic or Organic Chemistry (Theo. and Pract.) (b) The other under (a), or Dyeing, or Gas Manufacture, etc.
Optional	One subject under (b) for first year	One subject under (b) for first or second year	As for second year

All these courses manifest a desire on the part of those who direct Technical Education to systematise their instruction, and to direct the student's course of study so as to obtain the maximum result with the minimum of effort. The most carefully planned courses involve only three nights a week; those which ask for more may be regarded as counsels of perfection, or as containing alternative subjects. In the latter case, most of the advantages of systematic courses are immediately lost. There are serious objections to alternative subjects in any case, and it may be fairly asked, for example, whether the five alternative first year courses in Mechanical Engineering at Woolwich (p. 113) are equal in value as a preparation for the single second year course suggested.

Many of the schemes exist only on paper, but that does not obscure the trend of opinion, and their general introduction may be looked for when the obstacles inseparable from a period of transition have been overcome. The difficulties find expression in the want of agreement upon essentials, in the difference of standard at any particular stage, and in the palpable divergence of aim (*cf.* Mechanical Engineering at Manchester and Bolton).

The chaotic condition of secondary education, and the fact that the Continuation Schools have been hitherto under independent managers, have stood in the way of a definite standard of admission, even in towns with similar educational organisations. Both these drawbacks are being rapidly removed under the Act of 1902.

The comparatively short time that evening students

can devote to the classes limits the number of subjects which can be taken in one year, while the enormous progress in the applications of Science to Industry imposes in each decade a wider and wider curriculum. The limitation is most serious in those courses which contain merely the subjects in which the Board of Education hold examinations; and the freedom, conferred upon local authorities by the Regulations, of drawing up schemes of study adapted to local circumstances seems to have been exercised only in a particular direction. Many schemes of study based upon the syllabuses of the City and Guilds of London Institute have been recognised for Parliamentary Grant, but the number of cases in which special courses in, *e.g.*, one or more branches of Physics and Chemistry, have been drawn up, is comparatively small. Year by year the standard of the Examinations goes up, and in order to keep up the record of examination results, it is found necessary to increase the time devoted to each subject. Moreover, the larger Institutions throw their well-equipped laboratories open to evening students, and this increases the time required in subjects in which practical instruction can be given. Mathematics is frequently taught in two-hour lessons; Machine Drawing and Building Construction often require two hours a night on two nights a week; while Applied Mechanics and Steam, formerly (and still in small towns) taught in one-hour lessons, now occupy two and a half or three hours. The two opposing principles of Catholicity and Specialisation here assert themselves, and not a few of the defects of curricula arise from the difficulty of drawing a line

between them. The position of this line is conditioned entirely by our estimate of the function of the Evening School in Technical Education, and in a voluntary system, impregnated with sentiment, that estimate is too often controlled by personal interests.

A word on the influence of examinations, by a Central Authority, may not be out of place here. It is sometimes stated that they are incompatible with locally organised courses of instruction; but this arises from a misconception. It is unfortunate that in this country examinations have been allowed to dominate curricula. Inspection has not been so long instituted on an adequate scale as to secure the universal respect of local authorities; and teachers, not without reason, have regarded maintenance of the examination record as the best means of demonstrating their efficiency. All the same, there is no reason why the examination should prove an insuperable barrier to skilful organisation. If the curriculum is adapted to the needs and capacity of the students, and the examinations are fitted to the curriculum, the complaint of incompatibility would largely disappear.

Finally, it may be said that while many of the courses show evidence of careful preparation, and nearly all are intended seriously, most suffer from certain defects. The causes which have been indicated earlier in the book may be summarised here. They are:

1. Failure to insist on an adequate standard of admission.
2. Failure to agree on essentials.

3. Failure to recognise that there is a rational order in which subjects should be taken.
4. Confusion of functions in regard to different classes of students.
5. Early specialisation with a view to examination results.
6. Neglect of liberality of basis necessitated by progress in the industrial applications of Science.

CHAPTER V

ATTITUDE OF EMPLOYERS OF LABOUR

NOTHING is more essential to the success of Technical Schools than the goodwill of employers of labour, and no discussion of Technical Education is complete unless this matter is considered. No one doubts that the British manufacturer has in the past exhibited an extraordinary apathy towards scientific progress, even when it affected his own industry; and has refused to employ, or, at any rate, to offer special encouragement to, the trained men that the Technical Schools have produced. At the same time, it is too often forgotten in the excitement of wholesale denunciation that there have been a number of instances in which individual employers have encouraged their hands by every means in their power to undergo instruction.

Some of the earliest and best examples of technical instruction in this country were carried out by the employers themselves. For many years Messrs. Mather & Platt, of Manchester, amongst others, held classes in Machine Drawing, etc., for their own employés.

It is equally true that many other firms remained quite indifferent to the question; and classes in their neighbourhood have indirectly suffered from this attitude. Foremen of the old school were not

always anxious to see young fellows obtaining information and training which had been denied to them in their youth, and in such cases numberless petty tyrannies made the earnest student's life anything but a happy one. In the minor trades the jealousy of the journeyman is an important factor, and one not easy to control. Lack of direct utility of the instruction in the industry itself has no doubt been instrumental in preventing recognition of the benefits of the classes. A certain form of instruction may be admirably adapted to those who are destined to occupy the higher positions; when this is given to those who in other respects are unfitted to advance so far, the result is sure to be disappointing. Clearness of aim in the classes is essential before any general and effective co-operation can be looked for.

So far as evening classes are concerned, the encouragement to attend them has taken various forms, of which some examples may be considered. The plan in some cases followed is to express approval of the classes, and to recommend employés to take advantage of the opportunities held out to them. But this is hardly sufficient, and more material encouragement in one way or another is to be observed. Thus the success of a student may entitle him to certain privileges in the works: it may be counted a factor in making promotions; it may carry with it an increase of salary; or it may be regarded as an essential condition of apprenticeship.

Messrs. Clayton & Shuttleworth, and Messrs. Rushton, Procter & Co., of Lincoln, undertake to fill certain vacancies in their drawing office each year

from among their own apprentices. In conferring this privilege, regard is had to a good time-sheet, a good-conduct report from the foreman, and success in evening classes during the previous two years. The early hour at which the works open in the morning, and the necessity of keeping good time, bears heavily upon those students who attend evening classes several times a week. The Bootle Education Committee have appealed to employers to permit their apprentices to start at a later hour on the morning following attendance at classes. As a consequence, the Leyland Line, Messrs. Fawcett, Preston & Co., and the Dublin Steam Packet Company, allow such apprentices to start at 7 a.m. instead of 6 a.m. Mr. T. M'Hugh's firm, under which the hours for commencement are later, makes a similar concession. At Derby, Messrs. Andrew Handyside & Co. have made arrangements for their apprentices to attend classes in prescribed subjects at the Technical College. The firm pays half the fees, and for all books and instruments during a period of three years. Those who pass the prescribed examinations receive increased wages, and are allowed to retain the instruments purchased for their use.[1]

Messrs. Vickers, Sons, & Maxim, of Sheffield, have for some years past awarded prizes to successful students in the neighbouring evening classes. They have recently adopted a scheme by which all apprentices in Section III. of their works who attend evening science and technical classes, and pass the examination laid down, receive for one year

[1] The *Engineer*, November 8, 1902.

following the examination one shilling per week extra wages for each of not more than three examinations passed in approved subjects. The allowance is subject to good conduct and proficiency in the workshops, and the scheme is to remain in operation for five years.[1] An elaborate scheme on similar lines to the foregoing has been drawn up by a Committee of the North-East Coast Institution of Engineers and Shipbuilders. So far as the proposals have reference to evening classes, they are here given in full:

"In starting apprentices, preference will be given to those who bring the best certificates of conduct and character, and the highest school-leaving certificates. The age of starting should be from fifteen to sixteen years.

"At the end of September in each year each apprentice will be awarded marks as follows:—For each approved examination passed during the year, 20 marks; for time-keeping, a maximum of 40 marks; for good conduct, perseverance, and progress in the workshops, a maximum of 40 marks.

"Marks for time-keeping will be deducted at the rate of one mark for every three hours lost; but no deduction will be made for special leave, or for sickness if certified by a doctor.

"Conduct marks will be awarded quarterly by the chief foremen of departments on the following scale: Very Good, 40 marks; Good, 30 marks; Fair, 20 marks; Moderate, 10 marks.

"An apprentice obtaining 60 marks will have the sum of sixpence added to his weekly rate of pay for the ensuing year, and for marks in excess of 60 his

[1] The *Schoolmaster*, August 15, 1903.

rate will be proportionately increased. For example, an apprentice who in any one year passed in two science subjects at an evening science school, will be entitled to 40 marks, for very good time-keeping 40 marks, and for general good conduct, perseverance, and progress in the workshops, a maximum of 40 marks—total for the year, 120 marks. This will entitle him to an increase of one shilling per week on his rate of pay, say, from 1st October for one year; but payments under this scheme will cease on the termination of apprenticeship or on dismissal.

"Should an apprentice obtain, say, 30 marks for time-keeping, and 40 marks for good conduct, perseverance, and progress, or a total of 70 marks, his rate of pay would be increased sevenpence per week, and so on.

"No payment under this scheme will be made to apprentices obtaining less than 60 marks, and apprentices who fail to obtain any marks for time-keeping, good conduct, perseverance, and progress, will be subject to dismissal.

"Apprentices commencing their apprenticeship between 1st October and 31st March will be entitled to half rates for their first year.

"Promotion in the workshops will depend upon marks obtained. Should an apprentice during the first three years of his time have shown marked ability at the evening classes, and obtained maximum marks for time-keeping, perseverance, and progress in the workshops, he may, at the discretion of his employer, be allowed to spend his fourth or fifth year at college day classes, the fees for which will be paid by his employer.

"At least one vacancy per annum in the drawing office will be filled by an apprentice obtaining the highest marks under the above scheme."

Under the Regulations for Pupils there are three schemes: (1) Scheme A has regard to youths who possess an engineering certificate or degree, and provides for a three years' engagement; (2) Scheme B provides for a six years' training on the Sandwich system, and is open to those who, having received a good general education, have also passed the matriculation examination required for graduation in Engineering at a college of university rank, or an equivalent examination. Pupils under both the above schemes receive higher rates of pay than the ordinary apprentice. (3) Scheme C states that "youths who, having entered the works as apprentices, succeed during their apprenticeship in passing the matriculation or equivalent examination prescribed under Scheme B, will for the remainder of their time be treated as pupils under Scheme B, in respect of leave to attend college day classes, promotion, and rates of pay."[1]

An equally interesting, but less elaborate, system has recently been adopted by the Great Western Railway Company at Swindon. In a notice issued from the Engineer's Office, all apprentices are told that they are expected to acquire a knowledge of Science and Drawing, and the subjects to which attention is specially drawn are: Practical Mathematics; Practical Mechanics; Geometrical and Machine Drawing; Heat, Electricity, and Chemistry. Those who have had no previous scientific

[1] *Technics*, Feb., 1904.

training are recommended to attend the preliminary group, which is provided for students between fourteen and sixteen years of age. They are advised to follow this up by attending the Engineering Course, which is intended for those between sixteen and twenty-one years of age. The work of the first two years of the latter course covers the ground upon which scholarships are awarded to apprentices between seventeen and eighteen years of age. The holders of these scholarships will pursue their studies in the subjects mentioned above at the day Technical School, on two afternoons a week. They receive their wages as if they were at the works, and the Company pays the fees. The number of scholarships is limited to thirty at any one time, and this number is distributed over fifteen first year, nine second year, and six third year students. Students who distinguish themselves will be allowed to spend part of their last year in the Drawing Office and Chemical Laboratory.

The Great Western is not the only Railway Company in the country which recognises the value of theoretical instruction. The London and South Western have introduced an original method in connection with their Nine Elms Works, the special feature of which may in part be attributed to the objection which the head of the Locomotive Department has to evening classes.[1] A notice was issued in September, 1903, to the effect that all apprentices would be allowed to attend classes during working hours. An entrance examination was held in Mensuration, Mathematics, and

[1] *Technics*, Feb., 1904.

Mechanics, at which 136 apprentices presented themselves. Seventy-four of these were considered to have passed, and the remainder were told that they would be required to reach the required standard by the next session.

The seventy-four students are divided into two groups, and each group attends classes at the Battersea Polytechnic on two mornings a week—once from eight to nine, and the other morning from eight to half-past nine. The subjects of instruction are Practical Mathematics and Mechanics, and the students are permitted to attend a class in Machine Drawing on one evening a week.

In the second year the subjects will be Practical Mathematics, with lectures and laboratory work on Steam and Heat Engines. Those who pass the annual examinations with sufficient credit will proceed to the following year's course; those who fail to do so will repeat the work for a second year, and if they are again unsuccessful, will not be afforded further facilities during working hours.

At the end of the third year the most promising students will be allowed to spend six months in each of the last two years of their apprenticeship at day classes in an approved Technical College.

Throughout the course all class fees are paid by the Company, and wages are paid as though full time was being kept in the shops.

The Directors of the London, Brighton, and South Coast Railway offer prizes to those of their employés who are taking systematic courses in Mechanical and Electrical Engineering at the Brighton Technical School.

Messrs. Howard & Bullough of Accrington credit each of their apprentices who attends two evenings a week at the Technical School with one shilling per week. At the end of apprenticeship the accumulated money is handed over to him, with 5 per cent. interest.

Some of the big ironmasters in Middlesborough and the Cleveland district[1] allow their apprentices to attend day classes on one day a week without deduction of pay for the time so spent. The subjects of instruction are Machine Construction and Drawing, Applied Mechanics, Theoretical Chemistry, and Electricity; the fee is six guineas per annum, half of which is paid by the employer, and the other half by the County Borough of Middlesborough or the County Council of the North Riding of Yorkshire. The firms which have so far granted this privilege are:

The Tees Side Bridge & Engineering Company, Middlesborough; Richardson Westgarth & Co., Middlesborough;[2] Bolckow, Vaughan & Co., Middlesborough; Head, Wright & Co., Stockton.[3]

Again, at Bolton there are three or four hundred apprentices attending evening classes at the expense of their employers. Some firms give ten, others twenty, and so on, of these scholarships, and their

[1] A similar scheme is in operation at the Municipal School of Technology, Manchester.

[2] This firm has issued a circular similar to that of the North-East Coast Institution of Engineers and Shipbuilders, at their Hartlepool Works. See the *Engineer*, 2nd October, 1903.

[3] For the above information the writer is indebted to Douglas Smith, Esq., Secretary to the Education Committee of the North Riding County Council.

value is about twenty-five shillings each, covering fees, books, instruments, etc.

Messrs. Palmer's Shipbuilding Company of Jarrow-on-Tyne issued a circular to their apprentices in 1902, the principal provisions of which are as follows:

(*a*) Any apprentice who passes in certain subjects before the end of his third year (nineteenth birthday) shall receive one shilling a week extra pay during his fourth and fifth years. The subjects are:

Practical Geometry.
Mathematics (Algebra, Euclid, Arithmetic, and Mensuration).
Applied Mechanics.
Steam—all in the Elementary Stage.

(*b*) To any apprentice who passes in certain subjects before the end of his fourth year, two shillings a week shall be allowed during his fifth year. The subjects are:

Practical Geometry.
Mathematics.
Machine Construction and Drawing—all in the Advanced Stage.

(*c*) To the apprentice who obtains the best results in all the above subjects before reaching his twentieth birthday, and whose record for conduct and time-keeping in the shops is good, the privilege of spending the last year of his time in the drawing office is accorded. The selection of the apprentice shall be made by the manager.

Every facility will be given to apprentices attending classes, by not requiring them to work overtime on class evenings.[1]

No Engineer has been more prominent in advocating facilities for theoretical and practical training for Engineering students than Mr. A. F. Yarrow.

The regulations[2] for the admission of pupils and apprentices to his works at Poplar, as set forth below, are of considerable interest.

Regulations for the Admission of Pupils, Scheme A. — Candidates who have obtained first-class certificates after a complete course of instruction extending over three years, at an approved technical engineering college, or who have obtained a first-class honours degree, or its equivalent, in an approved engineering course at a University, may be admitted.

They will receive pay at the rate of twenty shilling a week on entry, with an annual increase of five shillings per week.

Candidates who have received a similar training, but have obtained lower class certificates, may submit their names to the firm for admittance if they can be strongly recommended by their professors; but, in any case, those who obtain the highest honours will have the preference.

The time to be served will be three years, the third year being spent in the drawing office if the workshop record has been satisfactory.

Scheme B.—Candidates who have not obtained

[1] *Engineering*, 2nd October, 1903, p. 464.
[2] The *Engineer*, 26th June, 1903.

University or Technical College Certificates must be between the ages of sixteen and nineteen. They must be examined before entry by a competent examiner, chosen by the firm, in the following subjects:

Arithmetic and Mensuration.
Algebra to Quadratic Equations.
Geometry up to the standard of Euclid I., II., III., IV., and VI.
Theory and Use of Logarithms.
Trigonometry up to Solution of Triangles.
Elementary Theoretical Mechanics, Heat, and Electricity.
Freehand and Mechanical Drawing.

The matriculation examination of an approved University, or the "School Leaving Certificate" of the University of London, will be accepted so far as the subjects have been covered.

Any candidate who has a more advanced knowledge of Mathematics or Science above the standard indicated by the foregoing list, will be at liberty to submit a statement of the additional subjects in which he might desire to be examined.

The rate of pay will be ten shillings a week on entry, with an annual increase of five shillings a week.

Recognising that a scientific education is an essential factor in a young engineer's training, every facility will be given to pupils entering under Scheme B for attending evening classes, and it is required that at least two evenings a week shall be devoted to study.

The time to be served will be four years, the fourth year, if the workshop record has been satisfactory, being spent in the drawing office.

Scheme C.—It being the firm's strong conviction that the best course of training for engineer pupils consists in spending the winter months at a University or Technical College, and the summer months in practical work in the shops, they are in consequence desirous of giving every facility for carrying this system into effect in the case of pupils entering under the conditions of Scheme B, if a complete and satisfactory course, occupying six to seven months during the winter in each year, can be arranged at an approved technical engineering college.

Under this scheme, work in the shops may be combined with a University or Technical College course.

The rate of pay while in the shops will commence at ten shillings per week, rising gradually to thirty shillings a week. This scheme may be extended to pupils who are doing post-graduate work, having entered the workshops under Scheme A.

General.—No premium is required under any of the above schemes. Candidates under Schemes A, B, and C must give proof that their school and college career has been satisfactory as regards diligence, punctuality, and general conduct, and they should give an account of any prizes or other distinctions they may have obtained.

Pupils will be requested to serve three months on probation. All pupils will be required to start work at 6 a.m., and to conform to the regulations of the

establishment. They may be dismissed at any time if their conduct is not deemed satisfactory.

It is desirable that pupils should reside within a two-mile radius of the works.

All pupils must enter into an undertaking jointly with their parents and guardians to remain for the full term specified in the event of the firm desiring to retain them, and their admission depends upon there being vacancies.

The firm reserve to themselves the right to ask any pupil to retire from the works should he not be considered by them suitable for the profession of an engineer, or should he be irregular in his attendance, or have indifferent health.

It being very desirable that pupils should visit manufactories, works in progress, etc., every facility will be given to take an afternoon off—not, however, more frequently than once a month—with this object in view.

The firm reserve to themselves the power to modify these schemes in exceptional cases at their discretion, but no personal influence will in any case be allowed to affect their decision.

Regulations for the Admission of Apprentices.

Apprentices enter at sixteen years of age or under. Admittance is only given after satisfactory proof has been given that during their school life they have been diligent and regular in their attendance, and are especially apt in those subjects which it is necessary for an engineer to be well acquainted with.

At the time of their application detailed particulars of their school career is to be given, with a statement

of prizes and certificates, or other distinctions which may have been gained during that period.

No personal influence is to interfere with the carrying out of this system.

The rates of pay is to be six shillings, eight shillings, etc., a week, advancing by two shillings a week annually.

The apprenticeship period is to expire at twenty-one.

Every facility will be given to apprentices for attending evening classes, and it is expected that at least two evenings a week will be devoted to study, on which evenings they will not be required to work overtime.

All apprentices will be required to conform to the regulations of the establishment, and they may be discharged at any time if their conduct is not deemed satisfactory.

Apprentices should reside within a two-mile radius of the works.

Those who at any time can pass the examination required by Scheme B for the admission of pupils, will come under the regulations which apply to pupils.

Examples of encouragement by employers in industries other than Engineering are less often met with, and are generally less definite than in the Engineering Industry. At the same time, there are many cases of individual effort which, with a little trouble, might be crystallised into a definite system. The members of the Lincoln Builders' Association not only give prizes to successful students in the local classes, but also insert a clause in the indentures

of their apprentices requiring them to attend evening classes at the Technical School during the first two winters. Another example is that of the Master Painters' Association of Bradford, whose apprentices attend classes at the School of Art on five afternoons a week for one year.

Many attempts have been made to maintain the standard of work in Plumbing by requiring that none but duly qualified and registered men shall be employed. In October, 1901, a circular was addressed to local bodies acting in conjunction with the Worshipful Company of Plumbers, and also to the associations engaged in the Building industry, in the chief centres of the kingdom. The document commenced:

"The Committee of Representatives of District Councils for the following places—Belfast, Birmingham, Bradford, Cardiff, Dublin, Edinburgh, Glasgow, Leeds, Liverpool, Manchester, Nottingham, Plymouth, and Sheffield, acting in conjunction with the Plumbers' Company, deem it highly desirable that a prescribed apprenticeship or course of training should be recognised in connection with the National Registration of Plumbers. A special form of indenture has been prepared for the purpose by a conjoint board composed of representatives of the 'London Society of Associated Master Plumbers,' the 'United Operative Plumbers' Association of Great Britain and Ireland,' and the 'Plumbers' Company.'"

In the form of indenture suggested:

"Covenants are expressly provided for (1) the attendance of the apprentice at approved classes of technical instruction; (2) the apprentice presenting

himself for annual examinations in technical knowledge and workmanship in conformity with such rules and regulations as may from time to time be prescribed in connection with the National Registration of Plumbers; (3) the cancelling of the indenture after due notice to the parties in the event of the apprentice failing to pass a satisfactory examination in the third year of his apprenticeship, provided such cancelment be recommended by the examining body."

Town, County, and Urban District Councils could exercise considerable influence in matters of this sort, and now that they are more closely concerned with the control of Technical Education, they will no doubt show greater interest in the proper training of Plumbers. In a courteous letter to the writer, the Secretary of the Worshipful Company of Plumbers states:

"There are at present in London, as well as in various parts of the country, several apprentices taken on the form of Indenture. The Company also keep a Register of Apprentices, upon which some twenty to thirty apprentices have been entered."

Mining is in the same condition as Building in regard to lack of definite schemes of encouragement. A number of colliery owners have agreed to pay the fees and (or) train fares of some of their employés whom they propose to send to the Course of Lectures on Saturdays at the Durham College of Science, Newcastle-on-Tyne. The pupils of Mr. J. P. Gibbon, Agent to North's Navigation Company, Maesteg, Glamorgan, are required by their agreements to

attend evening classes. Moreover, the support (something like £25,000) given by colliery owners to the Wigan Mining School is evidence that the value of Technical Education is fully recognised in this industry.

In Metallurgy the conditions are altogether different. One or more skilled chemists, and in iron and steel works a trained engineering staff, are employed, but the former have often received their training before entering the works. In a number of cases the ordinary operations of analysis are carried out by superior artisans, who are capable of following instructions without knowing anything of the processes involved. Where boys are engaged, there are some cases in which the term of apprenticeship is shortened if the lad proposes to go to a Technical School at its conclusion. There is a good deal of scope for experiment in connection with this industry. Lads who, while engaged in the works, had shown ability in evening classes, might be offered a period in the Laboratory, and *vice versâ*.

Attention may be drawn to two points. In the first place, there is evidently a feeling that while all employés should undergo theoretical training, the apprentice—or his modern equivalent—is the one upon whom pressure can and must be brought to bear. Secondly, there is a manifest tendency to systematise the instruction, and to grant privileges as rewards for success in an approved course of study. Once these two points are generally recognised, the extension of the co-operation between Technical School and Workshop is assured. The capacity and prospects of the apprentice have

too often been limited and hidden by the preponderating claims of the journeyman, with his inadequate preliminary training, and in spite of his earnestness of purpose, his narrower view. The fear of driving students away has frequently prevented the Technical Schools from demonstrating their aim with sufficient clearness, from prescribing and insisting on courses of study, from adapting themselves to the changed conditions of industry, and becoming at once a part of the industrial and educational machinery of the country. With the wise support of employers, they can look forward with confidence to a constant influx of students with a common level of attainment and a common aim, to give them that stability of numbers and regularity of attendance which is so necessary for the organisation of really efficient and suitable courses.

The value of the experiments which are in progress in connection with both the arrangement of courses of instruction and the closer association of the interests of the industry and the schools can hardly be overrated. Still, in these examples of individual enterprise lies a danger as inseparable from infinite diversity as it is from conformity to a rigid plan. Experiment is desirable, and indeed at the present time essential; unless, however, it is carried out on a rational rather than a purely empirical basis, it may not only lead to waste of effort, but may retard in some cases the progress of Technical Education by producing disappointing results where a more careful consideration of educational principles would have secured success.

There is no doubt a prevailing horror of uniformity, as tending to reduce freedom of initiative and to

cramp development. All professional education, however, *e.g.*, Law and Medicine, is stereotyped as to standard of admission, subjects, but not method, which, within certain limits, is always determined by the personal equation of the teacher. The possession of University degrees in Engineering, no matter how different the methods of the schools may be, imply similar standards of knowledge. Surely an intelligible standard should be aimed at in what Sir William White calls "lower technical education." Some diversity there must always be in any action taken by employers, because what the organisation of one works will permit, that of another will not. But an approach to uniformity, or, at any rate, some standardisation of curricula, is possible, and this is essential if the instruction is to have a value more than local.

In view of the probability that definite action by the employers in favour of theoretical training is likely to increase, some features of the various methods in operation may be discussed. It should be noted that in Engineering there are, as a rule, no articles of apprenticeship. A lad is not bound to his employers for any particular length of time, nor are they bound in any way to provide instruction for him. He is simply taken on, set to work, and paid a wage which depends entirely upon his age; and whenever he joins, his apprenticeship—such as it is—lasts until he is twenty-one years of age. His work is confined, in nearly all cases, to one department, and there is really little to distinguish it from that of the journeyman.

It will have been observed that several of the

schemes contemplate shifting the apprentice who has distinguished himself from one department to another, and this is perhaps the most valuable stimulus that can be given. The youth not only derives an added interest from the variety of work he has to execute, but the all-round experience will be of the greatest use to him in enabling him to take advantage of theoretical instruction in after life. The drawing office, in particular, is a goal of ambition for many young men, and possesses charms over and above the fact that it is a nine o'clock in the morning job. The North-East Coast scheme and that of Mr. Yarrow rightly insist on a high standard of general education on admission—a matter which should have serious attention in all future arrangements. There is no greater stumbling-block to progress beyond a certain point than defective early training. The reports of the Mosely Educational Commission show that this point is not being lost sight of in America.

The schemes of the two Railway Companies provide in different ways for weeding out the unfit. The London and South-Western exclude those who show that they possess no natural aptitude for study, or lack of perseverance, and the Great Western encourage those who show that they do possess the right qualities. It has been said that the London and South-Western scheme could not be carried out by every engineering firm; and this is probably true, in spite of the comparatively small amount of time given from the working hours. Difficulties would doubtless be experienced by marine repair shops, for example, in which the work comes in with a rush.

For most works, however, the Great Western scheme is well within the bounds of possibility, and the cost is not prohibitive. Thus, assuming the thirty students in attendance at the Technical School receive on the average ten shillings for a fifty-four hour week, the net loss in wages for a session of thirty weeks would be £50, and the fees would amount to £60, making £110 a year in all. There is the additional advantage both to employer and employed in the feeling that the privilege has been well earned. Some people may have an objection to a method which seems to bribe apprentices to attend classes, and if real inducements in the way of promotion are held out, it does not seem necessary to adopt other methods. The object is to seek out and develop innate ability and perseverance; not to create a somewhat artificial enthusiasm amongst a large number, many of whom may fail to benefit by the instruction. Whether a desire for self-improvement and advancement under favourable conditions is sufficient, time alone can show, and in any case different trades may call for differences of method.

The writer believes that the following plan would in general be the easiest of adoption, most economical in working, and productive of the best results.

1. Apprentices to be encouraged to attend systematic courses of instruction in evening classes, so arranged as to provide a suitable basis for future work, and to involve as little strain as can be secured.

2. A proportion of apprentices who have distinguished themselves by diligence and progress, to be sent on two afternoons or one day, with one or

two evenings a week for Drawing, to the Technical School.

3. The best students to pass, with the aid of scholarships if necessary, to the full day course at the Technical College, for two or three years.

The pupils would in each case pay their own fees, unless they held scholarships awarded by local education authorities or by their employers. There should be a sufficient number of such scholarships to ensure that no deserving student shall be excluded for lack of means.

Such a scheme would be eminently suitable for the Building trades. During the winter months work is slack, and in most cases the apprentices could be well spared. Even in Plumbing the journeymen could probably cope with the repairs occasioned by frost. The plan would also be suitable for Mining and Metallurgy.

The above suggestions are by no means so revolutionary as those proposed in a thoughtful article on "The Nation, the Apprentice, and the Polytechnic,"[1] by Dr. S. G. Rawson. He considers the case of the boy or girl who completes the Sixth Standard at the end of his or her twelfth year, and would make attendance at a Higher Elementary School for the next two years (say to fourteen and a half) compulsory. The greater number who leave at fourteen and a half would enter business or workshops. "There they should remain for two years, attending by compulsion on two afternoons and three evenings per week at the nearest Technical Institute." At the end of that time he considers

[1] *Contemporary Review*, 1901, p. 584 *et seq.*

that the employer should send selected apprentices for at least two years to the day Polytechnic, paying wages all the time, and receiving the apprentice back into the works during vacations.

The argument is supported by quotations from the report of Mr. James Baker on "Technical and Commercial Education in East Prussia, Poland, Silesia, and Bohemia," where similar arrangements are enforced by law. There is, however, an innate dislike of compulsion in this country, and there is reason to believe that some such scheme as that outlined on pages 185 and 186 is within measure of attainment. The period of prosperity which the nation has enjoyed for a number of years is doubtless responsible for much of the conservatism to be met with, but there are not wanting signs that public opinion will sooner or later stimulate the vigorous reorganisation of educational and industrial methods that is so completely the need of the hour.

If such a scheme comes into general operation, it will be more than ever necessary to secure more definiteness in the evening instruction. About fifty apprentices were admitted to the Monday classes at Manchester[1] during the first session, while at Middlesborough[2] the numbers have varied from thirty to six. Unless they are of fairly equal standard, and there is some rational connection between the evening and day curricula, by which the backward can attain this standard, even the simplest classification into first, second, and third year students will be impossible.

Finally, it may be noted that the suggestions bear

[1] Page 127, footnote. [2] Page 127.

considerable resemblance to the system of training apprentices in the Royal Dockyards. Lads are admitted between fourteen and sixteen years of age on the results of a competitive examination, and receive instruction on two afternoons and three evenings per week during the first four years of service. Examinations are held half-yearly, and there is a continual weeding-out of those who show themselves unable to profit by the instruction.[1] The scheme outlined differs from the Admiralty scheme in that the Evening School alone is employed for the weeding process before the day courses begin. It has been stated[2] that questions of cost would render the dockyard plan impossible in the case of smaller firms. But a reference to the financial aspect of the Great Western scheme (p. 185) shows that the expenditure is comparatively small. And in towns where there are several small firms this would become still less significant by distribution.

[1] The matter is again discussed on page 253. For a full description see *Cassier's Magazine*, November, 1902, p. 205 *et seq.*

[2] "What the Admiralty has done large employers can also do, though not perhaps to so great an extent."—Sir William H. White, *Technics*, January, 1904.

Note.—It should be stated here that no reference has been made to the benevolent gifts of wealthy men who have built and aided Technical Schools. These gifts have in many cases provided the means of Technical Education, but they hardly come within the province of this chapter.

CHAPTER VI

THE RELATION BETWEEN EVENING AND DAY TECHNICAL SCHOOLS

WHEN considering the function of Evening Schools in a general scheme of Technical Education, stress was laid upon the necessity of providing for those who by inclination and opportunity would elect to continue their studies at a Day Technical College. Two matters are thereby opened for discussion. The first is how far the Evening Curricula which have been described form a suitable preparation for the first or later year's course at the Day College. The second is how far various systems of awarding scholarships offer sufficient facilities for advancing deserving students.

As to the former, no wisely organised system can avoid recognising the necessity of co-ordinating the different agencies. In the present state of divided opinion the colleges are, as a rule, glad to take students either direct from school, or after a period has been spent in the works. The minimum age of admission is sixteen, or in a few cases fifteen, and evidence is generally required that the candidate

has received a good general education. Entrance examinations are not universally insisted upon, but the University Colleges and London Polytechnics naturally bring pressure to bear upon students to matriculate, with a view to graduation, though they have also established in a number of cases Certificate or Diploma Courses, for which matriculation is not necessary.

For a student who does not wish to graduate, a test in English Composition and Elementary Mathematics is all that is required as a rule. The student who cannot satisfy the authorities on this point has certainly no claim to be admitted, and it is to be hoped that the attention which is now being paid to secondary education, together with the more general recognition of the value of technical training, will result in a much higher standard of admission being imposed.

The day courses of instruction rarely assume any special knowledge on the part of the student on admission; at any rate, the entrance examinations never contain science papers beyond matriculation standard, except for the purpose of selecting scholars; and, as has already been remarked, not even this is looked for from students in diploma courses.

All technological day courses involve more or less instruction in the fundamental subjects, Physics and Chemistry. The amount considered necessary varies, even where similar standards are reached in the applied subjects; but some is always given. Now the student who elects to go through a period of workshop training before proceeding to college, and

attends evening classes during that interval, will find himself face to face with certain difficulties due to the complete independence of the curriculum of the Evening Technical School. He will find that he has already considerable knowledge of some of the subjects of the first or second year's College course, but not to the same standard in each. As evening courses of instruction are at present constituted, he will have obtained a knowledge of the applied subjects which is greatly in excess of his knowledge of fundamental subjects as measured by comparison with the student who, starting under exactly the same conditions, has gone direct from school to college. He will have specialised as much as the first or second year day student, without having attained his breadth of general and scientific education.

How great this difference is, and its exact nature, is best brought out by comparing the number of hours which a student will have spent in studying a given subject after certain periods under the two conditions. The first comparison may be made with the carefully organised day and evening courses of the Municipal School of Technology, Manchester. The figures represent the number of hours which a student will have devoted to each subject over a period given at the head of each column. The courses chosen are those in Mechanical Engineering.

Subjects.	Two Years, Evening	One Year, Day.	Four Years, Evening.	Two Years, Day.
Mathematics, - - -	120	200	240	340
Geometrical and Mechanical Drawing, - -	180	240	180	474
Mechanics and Steam, with Laboratory Work,	60	100	420	410
Physics, - - - -	—	200	—	270
Chemistry, - - - -	—	200	—	270
Electrical Engineering, -	—	—	—	100
Workshop, - - - -	5000 (*about*)	100	10000 (*about*)	340
English, - - - -	—	70	—	70
German, - - - -	—	70	—	140

In estimating these figures, it has been assumed that the evening session lasts thirty weeks, and the day session, when examinations are allowed for, thirty-four weeks, approximately. The table brings out the fact that in the years selected for comparison the evening student has put in about two-thirds of the time of his day *confrere* at Mathematics, but has spent quite as much time—and presumably reached the same standard—in Mechanics and Steam. Can we assume that two-thirds of the Mathematical knowledge which one man must have is sufficient for another to reach the same standard in Applied Science? The difference in the case of Mechanical Drawing is not great in the first case; in the second it is out of all reason, if the courses are intended for the same types of men with similar capacities and objects in life. At the same time, there is another possibility to be kept in view. If the evening

student spends three months in the drawing office during his apprenticeship, he will be able to add five hundred hours on to the time given for this subject, and this is a contingency likely enough to arise.

The real contrast between the courses comes out in the time spent upon Physics and Chemistry. The importance of these is fully recognised in this, as in nearly all other *day* courses, while in *evening* courses it is as uniformly ignored.

Before proceeding further with the discussion, another example may be examined. It is that of the West Ham Municipal Technical School. The courses are again those for Mechanical Engineering, which, in this case, are based upon the University of London syllabuses.

Subjects.	Two Years, Evening.	One Year, Day.	Four Years, Evening.	Two Years, Day.
Mathematics, - - -	30	170	70	320
Mechanical Engineering (Mechanics and Steam),	180	170	540	440
Geometrical and Mechanical Drawing, - -	120	60	120	160
Physics and Electrical Engineering, - -	—	270	—	510
Chemistry and Metallurgy, - - - -	—	170	—	270
Workshops, - - -	5000 (*about*)	160	10000 (*about*)	310

The disparity between the amounts of time spent upon Mathematics and Engineering subjects is here

most marked, while the amount of time given to Drawing is very nearly the same in each. Physics and Chemistry are not taken in the evening courses, and this in spite of the fact that in the other subjects nearly identical syllabuses are followed.

That the main difference between day and evening curricula is the neglect of the fundamental subjects by the latter may be verified by comparing any of the courses in Chapter IV. with the following day courses.

The figures given there are the number of hours per week devoted to each subject or group of subjects. In order to effect the same comparison as above, the figures must be multiplied by 34 and 30 respectively, which is approximately the number of weeks in the year the instruction covers.

All this comparison points to one conclusion: that if the day courses are sound, the evening courses are correspondingly unsound. And it is quite certain that if the Evening Technical School is to pass a proportion of its students on to the Day College, a radical alteration in its methods is necessary.

ENGINEERING AT BIRMINGHAM UNIVERSITY.

Subjects.	First Year	Second Year	Third Year
Mathematics,	4	8	—
Physics,	5	—	3
Chemistry,	$5\frac{1}{2}$	—	—
Metallurgy,	—	2	3
Engineering,	14	23	22

Engineering at Manchester Technical School.

Subjects.	First Year	Second Year	Third Year
Mathematics, - - - -	6	4	1
Physics, - - - - -	6	3	3
Chemistry, - - - - -	6	2	—
Metallurgy, - - - -	—	—	2
Engineering, - - - -	13	25	25

Metallurgy at Manchester Technical School.

Subjects.	First Year	Second Year	Third Year
Mathematics, - - - -	6	—	—
Physics, - - - - -	6	4	—
Chemistry, - - - - -	6	12	[illegible]
Engineering, - - - -	13	6	9
Metallurgy, - - - -	—	10	11
Geology and Mineralogy, -	—	—	3
Chem. Engineering and Plant,	—	—	1
Surveying, - - - - -	—	—	3

Metallurgy at Birmingham University.

Subjects.	First Year	Second Year	Third Year
Mathematics, - - - -	4	—	Not given in the Calendar
Physics, - - - - -	5	—	
Chemistry, - - - - -	7	9	
Engineering, - - - -	5	8	
Metallurgy, - - - -	4	11	
Geology, - - - - -	—	3	

MINING AT BIRMINGHAM UNIVERSITY.

Subjects.	First Year	Second Year	Third Year
Mathematics,	4	—	—
Physics,	—	11	—
Chemistry,	2	—	—
Geology,	3	4	By Arrangement
Engineering,	—	8	5
Metallurgy,	—	—	11
Mining,	4	6	7

MINING AT UNIVERSITY COLLEGE, SHEFFIELD.

Subjects.	First Year	Second Year	Third Year
Mathematics,	5	—	—
Electricity,	—	1	8
Chemistry,	5	—	2½
Engineering,	14	4	—
Fuel,	1	5	1
Mining,	4	2	2½
Geology,	—	2	—

What proportion of students in Technical Schools and the Technical Departments of Universities have previously worked in evening classes is not easy to ascertain in any way short of a direct canvass. There must be a fair number holding County Council and other Scholarships, and if any conclusions can be drawn from the recent action of employers (Chapter V.), that number is likely to be increased. In both these cases they will be picked men, and on their behalf it

is assuredly desirable that the system of training shall be as sound and as effective as foresight can make it.

Leaving out for the time being the educational soundness of courses of instruction that ignore the fundamental subjects, leaving out the question of the mischief which results from specialisation on too narrow a basis, continuity of curricula in the case of institutions that must always be closely associated is surely worthy of consideration. Is it necessary that the student who wants to specialise in Technology, and does not care to go through the necessary groundwork, should be the first care? Are the difficulties of organising a progressive, well-balanced curriculum for Evening Schools that shall have a real connection with curricula below and above it, and form an efficient and solid link in our educational system, insuperable? Can there not be a definite and fairly uniform standard that shall make certain periods of study in evening classes equivalent to other (and shorter) periods in Day Technical Colleges? The fulfilment of one function of the Evening Technical School at least depends upon the answers to these questions, and if we agree to answer the first two in the negative, an attempt will be made in Chapter VIII. to answer the third.

In discussing the provision of scholarships for enabling evening students to proceed to the Day Technical Schools, it will be convenient to consider first the arrangements made by County Councils. Under this head systems of financial aid, to enable students to pursue more advanced work at certain centres outside the county area than can be followed in their own locality, will be described, mainly

because of their importance in rendering available a progressive system of instruction in thinly-populated districts. Probably the most elaborate scholarship system established by any Administrative County is that of the West Riding of Yorkshire. It will be sufficient to note here the Major Scholarships, Technological Scholarships, Coal Mining Exhibitions, and Technical Exhibitions.

The current arrangements provide for not more than fourteen Major Scholarships of an annual value equal to the College fees, if these are not more than £30, plus travelling expenses for distances over two miles, and a maintenance allowance of £25, which may in exceptional cases be increased to £35. Candidates must be between sixteen and twenty-five years of age, and must enter an approved University or University College. They must not as a rule have attended a College for more than two terms; in that case a higher standard of attainment will be expected. Scholarships are awarded in the first instance for two years, are renewable for a third, and in exceptional cases for a further period. They will be cancelled unless the Matriculation Examination is passed within one year, and the Intermediate within two years. The examination is held in April.

Subjects.

English, including Composition and Grammar. Outlines of English History and General Geography. Mathematics, including Arithmetic, Algebra to Quadratics, and Geometry (the subject-matter of Euclid I.-IV.)	Compulsory.

With three of the following:

Mathematics (a higher paper).
Mechanics.
Mechanical Drawing and Practical Plane and Solid Geometry.
Descriptive Physics (Sound, Light, Heat, Electricity and Magnetism).
Elementary Inorganic Chemistry (chiefly non-metals).
French.
German.
Latin.
Greek.
English Literature.
English History.

Six free studentships, four tenable at the Yorkshire College, and two at University College, Sheffield, are awarded in the same way.

The basis of the competition is the curriculum of the secondary school, but the limits of age permit of a student who has started on his career, but kept up his general education, entering for them. There is, moreover, a proviso in the Regulations which contemplates shop practice for Engineering students before they take up the College course.

The Technological Scholarships are four in number, and are of the value of £60 a year. They may be utilised for courses in connection with

(*a*) Textile Work;
(*b*) Dyeing;
(*c*) Mechanical or Electrical Engineering;
(*d*) Metallurgy;

(*e*) Any other industry sanctioned by the County Education Committee.

The scholarships are awarded in the first instance for one year; they are renewable for a second, and exceptionally for a third year. The holders will not, as a rule, be required to prepare for a University degree, but must take the certificate course of the institution attended. They must be between eighteen and thirty years of age.

Candidates must have studied for at least two sessions in local Technical Schools, and must produce a recommendation from the managers of the school which is endorsed by their employers. They must have had, moreover, at least three years' experience in workshops or their equivalent. Any period in the Design Room, Drawing Office, or Chemical Laboratory can only count in lieu of one of these years. Particulars must be furnished of the whole of a candidate's work in fundamental or allied subjects, and preference will be given to any who have followed a group course of instruction similar to those recommended by the County Council for Technical Exhibitioners (Chapter IV.).

The selection is based mainly upon the results obtained at the Examinations of the Board of Education and the City and Guilds of London Institute in specified subjects, but the Committee reserve the right to impose any other test they think fit.

The list of subjects for Engineering and Metallurgical scholarships is given below:

ENGINEERING.

The candidate must select subjects (not exceeding five in all) from the following list as those in which he elects to compete. He may submit for consideration successes obtained at any time since March, 1902.

But notwithstanding the restriction to five subjects, provision is made on the application form for information to be given by candidates as to their successes in any other subjects, or as to any work they may have done bearing upon their proposed course of study, but which may not have been tested by the examinations of the Board of Education or the City and Guilds of London Institute.

Mathematics, Stage 2 or higher. (Compulsory subject.)

And any four of the following:

Practical Plane and Solid Geometry.
Machine Construction and Drawing.
Building Construction.
Naval Architecture.
Theoretical *or* Applied Mechanics.
Sound, *or* Light, *or* Heat.
Magnetism and Electricity.
Inorganic Chemistry, Theoretical and Practical.
Metallurgy, Theoretical and Practical.
Steam.

Electric Lighting and Power Distribution.
Iron and Steel Manufacture.
Metal Plate Work.
Mechanical Engineering.

METALLURGY.

The candidate must select subjects (not exceeding five in all) from the following list as those in which he elects to compete. He may submit for consideration successes obtained any time since March, 1902.

But notwithstanding the restriction to five subjects, provision is made on the application form for information to be given by candidates as to their successes in any other subjects, or as to any work they may have done bearing upon their proposed course of study, but which may not have been tested by the examinations of the Board of Education or the City and Guilds of London Institute.

Inorganic Chemistry, Theoretical and Practical, Stage 2 or higher. (Compulsory subject.)

and any four of the following:

Practical Plane and Solid Geometry.
Machine Construction and Drawing.
Building Construction.
Naval Architecture.
Mathematics.
Theoretical *or* Applied Mechanics.
Sound, *or* Light, *or* Heat.
Magnetism and Electricity.
Metallurgy, Theoretical and Practical.
Steam.

Electric Lighting and Power Distribution.
Electro-Metallurgy.
Iron and Steel Manufacture
Metal Plate Work.
Mechanical Engineering.
Photography.

The actual subjects suggested and the alternatives might be criticised in some instances, but the list gives every chance to the student who has followed a systematic course in groups of allied subjects, while the method of selection of the students seems to leave nothing to mere chance.

Coal Mining Exhibitions are also awarded, tenable at the Yorkshire College, Leeds, University College, Sheffield, or similar institutions. They cover fees, travelling expenses over three miles, an allowance of thirty shillings for books, instruments, etc.; and are awarded for two years. Candidates must be over sixteen, and the selection may be made in three ways:

(*a*) On the result of a special examination in
English Composition.
Arithmetic and Mensuration.
Practical Coal Mining.

(*b*) On the results of examination after a series of University Extension Lectures in Mining.

(*c*) From among practical miners over twenty-five years of age who have passed Stage I. under the Board of Education, and are unable to obtain advanced instruction locally. They must be specially recommended by a District Sub-Committee.

Fewer precautions to secure soundness of preliminary training seem to be taken in the award of these Exhibitions than in other cases in this county.

The Technical Exhibitions are intended to enable students who have attended Continuation Schools to

take up suitable evening group courses. They consist of three kinds:

(*a*) *Junior Exhibitions*, tenable for three years, for persons between fourteen and sixteen years of age.

(*b*) *Senior Exhibitions*, tenable for three years, and renewable for a fourth, for persons over sixteen years of age.

(*c*) *Occasional Exhibitions*, for Advanced Work, tenable for one year, but renewable, for persons over sixteen years of age.

Exhibitioners (*a*) and (*c*) receive a grant in respect of fees, and the whole or part of travelling expenses over two miles. Exhibitioners (*b*) receive in addition a grant not exceeding thirty shillings for books. Junior and Senior Exhibitioners are required to attend on not less than two nor more than three evenings a week, and to take up not less than two nor more than four subjects according to the groups which have been arranged (Chapter IV.). Recommendations are made by the District Sub-Committees.

The Lancashire County Council offers Major Scholarships on the same lines as the West Riding, except that the award is made on the Joint Preliminary Examination of the Universities of Liverpool and Manchester. This involves a second language, and additional papers are set in Mathematics, Modern Languages, Mechanics, Physics, Chemistry, and Mechanical Drawing.

None of their other scholarships fall within the scope of this book, but there are a number of evening studentships of the value of £2, with travelling expense for distances over two miles. The holders must pursue a systematic course of instruction. The awards are made on the results of an examination in Arithmetic, with not less than two nor more than three subjects from the following list:

English.	Chemistry.	Arithmetic.
French.	Physics.	Algebra and Geometry.
German.	Mechanics.	Commercial Geography.

One half of the studentship is paid in November on the receipt of a certificate from the Authorities of the school stating that the holder has made satisfactory attendance and progress, and the other at the end of the session, provided that the student has made 80 per cent. of the possible number of attendances.

The Derbyshire County Council only awards Evening Technical Exhibitions, equal in value to railway fare, and the whole or part of the fees. The selection is made from documentary evidence of merit, and only one return journey per week is permitted.

Five Technological Scholarships, tenable at the Municipal School of Technology, Manchester, or elsewhere, are offered by the Cheshire County

Council. The value covers fees and travelling expenses, so long as these do not exceed £40. The award is for one year, but the scholarship may be renewed for a second or third. The subjects of examination are the same as those for admission to the Manchester School of Technology, viz:

English, including Geography and History.
Mathematics.
Freehand Drawing.
General Science (Mechanics, Physics, Chemistry).
Latin, French, or German.

Candidates must be over fifteen years of age, and must make over 90 per cent. of the possible attendances in each class per session.

In addition, there are thirty Evening Scholarships for Science and Technology, covering fees and travelling expenses up to £5. Students must be over fifteen years of age, and the award is made on past successes.

The County Council of Staffordshire offers six Major Scholarships—two of the value of £20, two of £30, and two of £40, tenable for one year, but renewable for a second, and under special circumstances for a third year. Candidates must be between the ages of sixteen and twenty-one. The subjects of examination are:

1. Arithmetic and Algebra to the Binomial Theorem.
2. Freehand Drawing or English Essay.

With three of the following:

3. Statics and Dynamics, or Trigonometry and Geometrical Conics.
4. German, or Chemistry.
5. French, or Experimental Physics.
6. Geometry.

In addition to the above, occasional scholarships of the value of £30 a year for not more than three years are awarded in Mining and Metallurgy. These are tenable at the University of Birmingham, and an additional allowance for maintenance may be made at the discretion of the Committee.

"They are awarded on the report of an Examiner specially appointed by the Education Committee on each occasion on which they are given. The examination is both written and oral, and the Examiner is entitled to make a report upon general grounds."

Six Technical Scholarships have been established by the Monmouthshire County Council. They are of the annual value of £40, together with free admission to all classes, and though awarded for one year in the first instance, may be renewed for two more years. Candidates must be between sixteen and twenty-two years of age, except in the case of two of the scholarships, one of which is reserved for those engaged in Mining, and the other for those engaged in some Engineering or Metallurgical Industry. The scholarships are awarded on the results of an examination in Mathematics, and not more than seven of the following subjects:

Theoretical Mechanics.	Principles of Mining.
Applied Mechanics.	Steam.
Practical Geometry.	Physiography.
Freehand Drawing.	Botany.
Sound, Light, and Heat.	Welsh.
Electricity and Magnetism.	French.
Inorganic Chemistry.	German.
Geology.	Machine Drawing or Building Construction.

An essay paper is set in addition to the above, which is not counted in the eight subjects, but which carries marks. For the Mining and Engineering Scholarships, preference is given to candidates who do well in Mathematics and Theoretical Mechanics. In the case of those who desire to study for a University degree, preference is given to those who have passed the whole or part of the Matriculation Examination.

The Glamorgan County Council maintains a number of free studentships at University College, Cardiff. Twenty of these carry a maintenance allowance of £30 a year, five of them of £20, and five of £40, and are tenable for three years. Candidates must be between sixteen and thirty years of age. The examination is in the following subjects:

1. Mathematics.
2. Theoretical Mechanics.
3. Inorganic Chemistry.
4. Sound, Light, and Heat.
5. Electricity and Magnetism
6. Applied Mechanics.
7. Steam.
8. Physiography or Geology.
9. Principles of Mining.

10. Practical Geometry.
11. Building Construction or Machine Drawing.
12. Freehand Drawing.
13. Modern Language, including Welsh.
14. Latin.
15. English Language.
16. History of England and Wales.
17. Essay.

Subjects 1 and 17 are compulsory. Three hundred marks are awarded for Mathematics, two hundred each for Theoretical Mechanics, Inorganic Chemistry, Latin, and the Essay. In the award, importance is attached to the success of the candidates in the Matriculation Examination of a University.

In addition to the above, there will be awarded on the results of an examination one studentship of £30 a year, with free tuition, to a student who has passed wholly, or in all but one subject, the Matriculation Examination of the University of Wales, and who intends to pursue the University course for the B.Sc. Degree in Mining; two studentships of the value of £30 a year for two years, with free tuition for students who intend to pursue the College course for the Diploma in Mining; and one studentship of £30 a year for three years, with free tuition for a student who intends to pursue the College course for a Diploma in Engineering.

The tables on pp. 213-217 indicate the provision of Entrance Scholarships and Exhibitions at a selection of Technical Schools and Colleges of University rank. Many of these are not intended specially for technical students, but it is not possible to distinguish

the object in some cases. The most striking feature is the variability of standard and scope. Much of this is probably due to the fact that they have been endowed by benefactors of the Colleges to foster certain branches of study, or to assist certain classes of students. As compared with those offered by the County Councils, the subjects exhibit a less clearly defined relation to the curricula of the schools from which students are drawn. There is, however, one point of similarity. The County Councils have, in a number of cases, based their requirements for Major Scholarships on the curricula of Secondary Schools, and in one or two cases on a University Matriculation Examination, while the Colleges award a large proportion of theirs on the latter test.

In regard to those scholarships which are awarded chiefly or entirely on an examination in science, the Colleges generally look for proficiency in a few subjects, and do not give so great a choice as the County Councils. Moreover, the Colleges usually give credit for a knowledge of literary subjects, while the Councils estimate a student's general education by an English essay. The absence of a recognised curriculum in Evening Technical Schools is probably responsible for the variety that exists in the requirements from candidates for Technical Scholarships, and it must be difficult in many cases for scholarship holders to adapt themselves to a definite stage in the College course.

The upper limit of age in many of the College scholarships will debar many candidates who have chosen or been compelled to enter industrial life

direct from school. Out of 101 scholarships for which the limits of age are given, 58 are confined to students under twenty years of age. When it is recalled that industrial apprenticeship only ceases, as a rule, at twenty-one years of age, it is obvious that these scholarships are not available for the majority of technical students. While the proportion in which the limit is over twenty years of age cannot be said to be unfair, it must be noted that these are not distributed evenly over the Colleges, and some offer none which are open to students who have reached that age. In some of these cases the deficiency is made up by County or Borough Scholarships, for which the limit is higher.

In view of the possibility of the reorganisation of Evening Technical Schools in such a way as to provide systematic courses of instruction, and of the manifest desire on the part of employers to encourage such of their apprentices who possess marked ability to proceed to Technical Colleges, it seems desirable that Technical Scholarships should be awarded on the subjects of the first year course at the College, in the particular faculty which the student desired to enter. The Colleges would then obtain students who could commence with the second year course. Those who, under ordinary circumstances, could only devote two years to day study, would thus reach a higher all-round standard than if their attainments on admission were such as necessitated their taking a hybrid course. Students who could give three years to study would be able to undertake research in their third year, and as they would have spent four or more years in actual practice, their work might

reasonably be expected to be of greater industrial importance than if carried out by students without this experience. The Colleges would reap an advantage in receiving older and more serious students, whose record would have demonstrated their aptitude for the industry in which they were engaged.

It is not clear how it is to be secured that the student shall have not only the special knowledge which will enable him to prosecute his technical studies with advantage, but also that general education which is so necessary for those who are to occupy the highest positions in the industrial world. The authorities who award the scholarship might undertake to give credit for the scholastic career of a pupil, and to take into account any distinction in a recognised school examination, and they could set an essay.

If a scheme similar to the above were followed, it need not be necessary to hold a special examination in the subjects of the first year. The method of determining promotion suggested on p. 61, applied to the Evening Technical School, would provide a means of selection which, recording steady progress over four or more years, would be quite as searching as a special test.

ENTRANCE SCHOLARSHIPS TO TECHNICAL SCHOOLS.

College.	No. of Scholarships.	No. of Years.	Value per Annum.	Limits of Age.	With Free Tuition?	How Awarded.
HARTLEY UNIVERSITY COLLEGE, SOUTHAMPTON	1	3	£30	Over 16	No	*College Entrance Examination*—Elementary Papers set in English Language, Literature, and History; Mathematics, Latin, French, German, Greek, Chemistry; Sound, Light and Heat; Electricity and Magnetism, Mechanics, Botany, Geometrical and Mechanical Drawing, and Logic. All candidates must take English, Mathematics, and one other language. Not more than two of the following advanced papers:—English Language, History, Latin, Greek, Mathematics, Chemistry, Physics, French, German, Botany, Mechanics, and Engineering Drawing and Design
	2	3	£24, £32 & £34	16-19 By prefer.	No	
	2	2	£24 and £32	,,	No	
	4	3	£12 or 15 guins.	,,	No	
	2	3	£25	Over 16	Yes	
	2	3	£30	16-19	No	
	2	2	£25	15-18	No	
	5	2	£25	Under 16		
UNIVERSITY COLLEGE, BRISTOL	1	1	£25	Over 16		*Subjects of Examination*—Chemistry (Junior and Senior). Mathematics. Physics. Engineering. Natural Science. Philosophy. Literature. Classics. French and German.
	1	1	£16	Under 19		
	1	3	£25	Over 16		
	1	1	£25	Over 16		
YORKSHIRE COLLEGE, LEEDS	1	3	£50	16-19		*Examination in*—English Language and Essay; Outlines of English History; French, German, Greek, or Latin; Mathematics, Physics, Chemistry, or Botany.
	1	2	£40	16-19		
	2	2	£40	16-19		*Examination in*—English Composition, Mathematics. With two of following:—Mathematics, Physics, Chemistry, Botany.
	1	2	£25	16-19		*Examination in*—English Language and General Geography English Composition, Mechanics, and Mathematics.

ENTRANCE SCHOLARSHIPS TO TECHNICAL SCHOOLS—*Continued.*

College.	No. of Scholarships.	No. of Years.	Value per Annum.	Limits of Age	With Free Tuition?	How Awarded.
UNIVERSITY OF BIRMINGHAM	2	1	£25	Under 19	No	*Matriculation Examination*— 1. English Language, Literature, and History. 2 and 3. Any two Languages.
	1	1	£24	?	No	4. Mathematics.
	2	3	£45	?	No	5. One of the subjects—Mechanics, Chemistry, Physiography, Botany, Animal Biology.
UNIVERSITY OF MANCHESTER	2	2	£40	16-20	No	*Examination in*—Pure Mathematics. Credit also given for knowledge of Literary Subjects.
	1	3	£35	16-20	No	
	2	2	£35	16-20	No	Mathematics, Mechanics, Chemistry. Credit given for knowledge of Literary Subjects.
	1	3	£30	16-20	No	
	1	3	£25	16-20	No	
	1	2	£23	None	No	Chemistry.
	1	2	£40	16-23	No	Mathematics, Mechanics and Heat, and Engineering.
	1	3	£40	None	No	Highest Aggregate at Government Science Examinations.
	4	3	£60	16-25	No	The Matriculation Examination of the University.
UNIVERSITY COLLEGE, LONDON	1	1	£30	Under 19		Two of the following subjects:—Mathematics, Physics, Chemistry, Elementary Biology or Botany.

ENTRANCE SCHOLARSHIPS TO TECHNICAL SCHOOLS—*Continued.*

College.	No. of Scholarships.	No. of Years.	Value per Annum.	Limits of Age.	With Free Tuition?	How Awarded.
UNIVERSITY OF LIVERPOOL	2	3	£20	Under 18	No	One paper in Greek, Latin, French, German, Italian, English History, English Essay, Mechanics, Applied Mechanics with Drawing, Physics, Chemistry, Biology, and two papers in Mathematics.
	2	2	£20	None	No	Not more than six nor less than four subjects to be taken.
	1	3	£40	Under 18	No	Essay compulsory.
	1	3	£35	None	No	
	5	2or3	£30	Under 19	Yes	
	1	2	£80	Under 22	No	On Whitworth Scholarship results.
	1	[illegible]	£30	Under 21	No	Do. do. do.
	1	2	£80	Under 22	No	See bracket above.
	1	3	£40	Under 18	No	
	1	[illegible]	£65	Under 18	No	
	2	3	£35	Under 19	No	
	1	3	£35	None	Yes	
DURHAM COLLEGE OF SCIENCE, NEWCASTLE-ON-TYNE	[illegible]	2	£20	?	No	Mathematics and one of the following:—Geology, Heat, Chemistry, Natural History.
	1	2	£15	?	No	All candidates must have passed the Matriculation or its equivalent. (This consists of four subjects, including two Languages other than English.)
	10	3	Free admission	?	—	Regulations from Town Clerk.
UNIVERSITY COLLEGE, NOTTINGHAM	2	3	£25	Under 17	No	*Subjects* — English Composition, Arithmetic, Mathematics, French or German, and one other subject. Standard and subjects, as well as limits of age, really depend upon course student proposes to enter.
	2	3	[illegible]	Under 17	No	
	2	3	£15	Under 17	No	

ENTRANCE SCHOLARSHIPS TO TECHNICAL SCHOOLS—*Continued.*

College.	No. of Scholarships.	No. of Years.	Value per Annum.	Limits of Age.	With Free Tuition?	How Awarded.
UNIVERSITY COLLEGE, SHEFFIELD	2 2	3 3	£45, £50 & £55 £24	? ?	No No	*Subjects*—General Knowledge and Mathematics, with three subjects from the following groups:— Group I. Higher Mathematics, Chemistry, Physics. Group II. Latin, French, German.
UNIVERSITY COLLEGE, CARDIFF	1 1 5 10	2 3 1 1	£35 £50 £20 £15 10s		No No Yes No	*Elementary*—Papers are set in:—Essay, Latin, Greek, Mathematics, English, History, Mechanics, Chemistry or Botany, Welsh, French, German. All papers may be taken. *Advanced*—Papers in:—Essay and Group A. Latin, Greek, Philosophy, History, Literature, Welsh, French, German. Group B Mathematics—two papers. Group C. Physics, Chemistry, Zoology, Botany, Geology, Philosophy. Two Subjects and Essay to be taken.
CENTRAL TECHNICAL COLLEGE, SOUTH KENSINGTON	1 1 1 3	3 3 3 3	£60 £50 £50 £30	16-21 ? Under 19 ?	No No No No	*Examination in*—Mathematics and Mechanics, Geometrical and Mechanical Drawing, Physics, Chemistry, English, French or German.
MUNICIPAL SCHOOL OF TECHNOLOGY, MANCHESTER	20	3	£50	16-25	No	*Subjects of Examination*—English, including Geography and History; Mathematics, two papers; Latin, French, or German; General Science, including Mechanics, Physics, and Chemistry; Model Drawing; Freehand or Geometrical Drawing.

ENTRANCE SCHOLARSHIPS TO TECHNICAL SCHOOLS—*Continued.*

College.	No. of Scholarships.	No. of Years.	Value per Annum.	Limits of Age.	With Free Tuition?	How Awarded.
MUNICIPAL TECHNICAL SCHOOL, WEST HAM	5	3	£25, £30, & £35	See how awarded	Yes	Awarded in two ways. I. To students between 14 and 18 years of age on Examination in Secondary School subjects.
	10	3	£10 10s		No	II. To students between 17 and 21 who have attended Evening Classes for three years on previous record.
TECHNICAL COLLEGE, HUDDERSFIELD	1	3	£15	Over 16	Yes	*Examination Subjects*—Advanced Chemistry, Mathematics, Physics and Elementary Mechanics. Credit given for French and German.
	3		£10	15-18	Yes	Mathematics + Two Science or City and Guilds Subjects + Two of following:—English, French, German, Latin, and Greek.
	1		£10	None	Yes	Results of May Examinations + French or German.
			Fees	Over 14	No	One Language + Mathematics + Three Science or City and Guilds Subjects.
TECHNICAL COLLEGE, SWANSEA	5		£25	16-20		Not more than two of following groups.— A. Mathematics. B. Physics, Chemistry. C. Three of following:—English, French, German, Latin, Welsh. Candidates must have passed Matriculation or Senior Certificate of C.W.B.
MERCHANT VENTURERS' TECHNICAL COLLEGE, BRISTOL						All candidates must be under 16.

CHAPTER VII

SUBJECTS AND METHODS OF INSTRUCTION

BEFORE an attempt is made to describe how curricula may be drawn up to meet the needs of particular classes of students in such a way that comprehensiveness is secured with the greatest economy of time and effort, it will be desirable to deal briefly with the chief subjects of instruction.

Since, moreover, methods of teaching are largely determined by the teacher's conception of the objects of his instruction, occasional references to matters under this head can hardly be avoided.

The subjects will be considered in the following order: Mathematics, Geometry, Physics, Chemistry, Drawing, Applied Mechanics and Steam, Mining, and Workshop Instruction.

For the courses to be considered the question never arises as to the inclusion or exclusion of Mathematics, but always as to the amount. In deciding this question, there are three considerations to be taken into account:

(1.) How much is required in order to enable a man to perform the ordinary calculations he meets with in his every-day work?

(2.) How much is required to enable him to follow the instruction in Applied Science that may be essential?

(3.) How much is required to enable him to follow current literature bearing on his own branch of the trade?

In seeking for answers to these questions, consider the case of the Engineering student first. So far as (1) is concerned, the amount is probably small, and will depend entirely upon the character of the student's employment. Occasionally men who have taken trouble to perfect their knowledge of this subject are disappointed at finding so little use for it in actual practice. Thus "Mernok," writing to the *Engineer*,[1] states that he has only used the calculus twice, and hyperbolic functions once in twenty-five years; while "Junior Draughtsman," writing to the same paper,[2] says he only knows one office where Higher Mathematics are employed. There is no doubt that the bulk of engineering work is carried on according to rules, tables, and data accumulated during years of trial, and that the amount of calculation to be done by men in practice is small, and is concentrated in a few offices. For the shop foreman or the ordinary draughtsman the amount of mathematical knowledge of immediate necessity is represented by the first stage of the Board of Education Syllabus in Practical Mathematics. This involves quick and approximate methods of dealing with vulgar fractions and decimals, logarithms, extraction of square and cube roots, mensuration of surfaces and solids, algebra as far as quadratic equations, graphical representation of varying quantities, with determination of the "law" in simple cases. Under (2) the amount necessary will depend

[1] 8th May, 1903. [2] 1st May, 1903.

upon the stage of progress aimed at in Applied Mechanics and Steam. An elementary knowledge such as is indicated above will be sufficient if the student desires only a practical working knowledge of what is usually regarded as second year work in these subjects. If, however, he is capable of proceeding to more theoretical and deeper study of Applied Science, a more advanced knowledge of Mathematics will be not only desirable but necessary.

The third factor to be employed in assessing the extent of Mathematical instruction is the most important. If a man is to keep in touch with engineering progress—and no educational institution can ignore the paramount necessity of placing its pupils in such a position that they can continue their studies after leaving with advantage — he must read current engineering literature. For this purpose a fair knowledge of Algebra, Geometry, and Trigonometry should at least be acquired. If the student is destined to occupy one of the more important positions in the industry, he will find himself severely handicapped unless he is familiar with the calculus and its simpler applications. Exceptions may be made in favour of the distinctly non-mathematical student, whose ability in other directions may compensate to some extent for a lower standard in this most important subject.

In regard to Mining, the requirements are not very different from those just considered. The opinion has already been expressed that the colliery manager, and the under manager who acts as his deputy, is, or should be, mainly an engineer.

The needs of Metallurgical Chemists might be

expected to be very modest, were it not for the fact that Physics finds an ever-increasing application in this industry. An estimate of the amount of mathematical knowledge ought to have regard to the extent of the student's physical studies. The scope illustrated on page 219 will enable the student to follow the instruction in the second stage of the Board of Education Syllabus in Heat; it will be deficient in Trigonometry for the second stage in Electricity, and quite inadequate for the second stage in Light.

In Building, the average student will find a sound knowledge of mensuration sufficient for his purpose. If, however, he proposes to prosecute his studies into the higher branches of construction, as in the case of an architect's pupil, his mathematical acquirements ought to be on the scale of those of an engineer.

So much has been written on the teaching of mathematics in recent years that a full discussion of the subject here is unnecessary. The general trend is to curtail the treatment of those portions which have no practical bearing, to avoid examples which are merely exercises in mental gymnastics, to concentrate attention on the value of the subject as a weapon to overcome difficulties, and to secure more exact notions in more concrete subjects. If this is the tendency where the school-boy is being considered, how much more essential is the new method in the case of technical students who have little time at their disposal, are by no means uniform in their mathematical faculty, and regard the subject as entirely subsidiary to their main studies? The new ideas have immensely widened the prospects of

technical students, and rendered it possible for them to undertake much that was formerly beyond their reach.

The method of regarding mathematics merely as an aid to the study of other subjects necessitates the introduction of mathematical truths at a stage when they cannot be rigidly proved, and this practice is liable to be abused. Good judgment is necessary in deciding questions of this sort. For example, the nature of logarithms may be explained to a student very soon after he has completed his study of decimals—when he understands the meaning of a "power of ten"—and their use illustrated by examples in involution, square root, and cube root. But it seems hardly fair to employ logarithms to solve triangles by the usual formulæ, until the universal application of the latter have been demonstrated. Again, a recent text-book introduces a chapter on the mensuration of the circle by stating the value of π, and then showing how it can be measured in a particular case. Would it not be more correct to let the class first grasp the fact that the ratio is constant by actual measurements? The mathematical value could then be given for subsequent use. The first method assumes that the pupil is already in possession of the fundamental idea—an assumption by no means justified in the case of evening students at this stage.

There seems to be very little reason for separating students engaged in various trades in the early stages of the work. A teacher can easily find examples to suit Mining, Building, and Engineering students, and should find but little difficulty in showing the practical value of the subject. Instruction which does not

permit of this can hardly be called Mathematics; it should be regarded as an extra class for working examples in the trade subject. Much good would result in this, as in other cases, if the mathematical and technical teachers were in consultation from time to time during the year.

The importance and the apparent neglect of Practical Plane and Solid Geometry have been noticed in Chapter III. An elementary knowledge of the subject has always been regarded as an essential preparation for good progress in Machine Drawing and Building Construction. While at one time the main objects were to secure accuracy in the drawing of plane figures, and to inculcate the principles of projection, the syllabus has been considerably altered in recent years. If one can judge from the interpretation of writers of text-books, it would appear that it now exercises a dual function. On the one hand, the importance of projection is kept in view; on the other, the subject may be regarded as an adjunct to Mathematics. This latter opinion receives support from the fact that in the Board of Education Syllabus of Practical Mathematics it is stated in effect that the student is supposed to be studying Practical Mathematics and Geometry together. It seems doubtful whether, in the smaller places, where teachers have, as a rule, narrower qualifications, both aspects of the subject will receive adequate treatment from the hands of one man. The more mathematical side would no doubt be admirably dealt with by the teacher of Practical Mathematics; projection would be more fully and usefully developed by the teacher of

Machine Drawing or Building Construction. Without laying any great stress on the point, the writer ventures to suggest that this division of the subject between two teachers may be worth consideration. One of the effects of such "correlation" would be that the student would learn three subjects where there need be nothing to show him that he was undertaking more than two. So long as the student can use instruments and understand simple constructions, there seems to be no clear reason for delaying Solid Geometry and Projection until after Plane Geometry has been thoroughly mastered.

As to the needs of various types of students, it may be said that those who do not aim at more than an elementary knowledge of Machine Drawing, Building Construction, etc., will find sufficient material in the first stage of the syllabus of the Board of Education. Students who wish to obtain a more advanced knowledge of these subjects should aim at securing a deeper knowledge of Practical Geometry. A more extensive knowledge of the development of surfaces and interpenetration of solids is required for certain classes of joinery, and for metal plate work. Such matters, however, belong to the special drawing courses which are arranged for men engaged in those trades.

Attention has already been called to the fact that a knowledge of Physics and Chemistry is of very great importance to the technical student. In the absence of an elementary knowledge of Mechanics, Heat, and Chemistry, very many points which arise in the study of Applied Mechanics and *Steam, Mining and Building* Construction, cannot be

understood. Teachers of these subjects must refer from time to time to "pure" science in dealing with its applications, and many text-books contain a brief account of the fundamental facts and principles. It is sometimes asserted that the technical teacher can be trusted to give all the instruction in these matters that his pupils may require. But while recognising that much will depend on the teacher, doubt may be expressed as to whether this method is of any real use. The idea that what is fundamental comes first seems axiomatic. A technical subject is largely an empirical subject; it can rarely be developed in logical order, and a single machine or process which may be under consideration may involve two or three fundamental principles. The preparation of the gases of the mine, and subsequent demonstration of their properties, would appeal to the student whose mind contained some ideas as to chemical change, and the nature of the substances, and who was familiar with the terms and methods which would have to be used during the lesson; and the information *might* be retained by a few students. But in the latter case, would this information be part and parcel of their mental equipment, connected with all the other ideas on the chemistry and physics of Coal Mining? Even to the few students who understood some of it at the time, would it not remain more like a glimpse into an unknown world? Does the Engineering student who has no knowledge of Heat or Chemistry ever really understand those parts of the technical teaching which deal with the properties of steam, the chemistry of combustion and water purification? And how many students of Building

Construction, similarly ill-prepared, understand the nature of the materials as expounded by the teacher, or read in the text-book?

It seems that the view that the theoretical explanation can be left to the technical teacher is absolutely at variance with a most important doctrine — the doctrine of Apperception. A new idea is assimilated only so far as it is able to associate itself with ideas which are already arranged in orderly manner in the mind of the learner. For the Mining teacher to assert that the ventilating fan depends upon Newton's first law of motion, and then to state that law,[1] is more likely to give rise to blank astonishment than anything else in a pupil who never heard of Newton, is not quite sure of what a "law" is, and has only a vague idea of what the word motion means. Even if the statement of the law is understood, the student has to remember a pair of isolated ideas, instead of one.

While a certain amount of information can be imparted in a didactic manner, the knowledge is not of the kind that is of real value. If the knowledge which the student acquires in the technical classes is to be of any use to him, it must be clear, definite, organised knowledge, and there appears to be no other way of attaining this end than to insist on systematic instruction in the elements of Physics and Chemistry, even for those who do not aspire to occupy more than a minor position of responsibility in their employment. So far as the writer knows, there is no royal road open to them.[2]

[1] This is an actual example.

[2] At the Engineering Conference mentioned in the first chapter, Professor A. B. Kennedy stated that evening classes

If it is conceded that this instruction is necessary, a question of interest arises as to who is to undertake it — the science teacher or the technical teacher? Leaving out the well-qualified staffs of the larger Technical Schools, there are few technical teachers who care to deal with the scientific principles, and as a general rule these should not be encouraged. In the majority of cases the technical teacher is a man who works at his trade during the day, and teaches on two or three evenings a week. His scientific knowledge probably has rusted by disuse, and it is unlikely that he will have had any training in experimental demonstration. The science teacher, on the other hand, is nearly always a professional teacher, regularly employed in lecture-room and laboratory, and constantly exercised in manipulation.

However, he is not without his defects, and the most serious is that his want of acquaintance with the applications of Science may lead to his failing to show the bearing of the subject on the occupations of the class. This is a difficulty that is responsible for no little criticism of technical education, and its removal is a matter of the greatest importance. A good deal towards this end could be accomplished by co-operation between teachers of Pure Science and teachers of Applied Science and Technology. Mutual discussion of syllabuses would be of considerable value in rendering the teaching of Chemistry

were injurious because the student learnt nothing but Engineering, and the man who confined his attention to Engineering subjects never made a good Engineer. Professor Barr referred to those who had made great advances in Engineering practice, and pointed out that "every one of these men had studied the sciences on which true practice must be founded."

and Physics less academic, and in fostering references to underlying principles in the applied subject. Further consideration of the equipment and training of teachers must be postponed until Chapter IX.

In deciding what portions of Physics are required, it is important to bear in mind that the branches should be taught in rational order. Mechanics precedes Heat, Heat precedes Electricity.[1] This is universally acknowledged and practised in day schools, and is, in fact, dictated by the logical connection between the subjects. It is not to be understood, of course, that the whole science of Mechanics is to be mastered before Heat is begun. But if it is proposed to study Heat, a certain amount of knowledge of Mechanics is essential. For the preparatory course suggested in Chapter II., the latter subject may include density and specific gravity; the simpler phenomena of hydrostatics; the barometer; some idea of force and motion; energy and work; and simple machines. The work in Heat will involve explanations of the construction and use of thermometers; the main facts connected with the expansion of solids, liquids, and gases; specific and latent heat treated in a simple manner; conduction and convection; and the mutual convertibility of heat and work. The treatment throughout should be experimental, but calculations should be carried out whenever these are within the mathematical capacity of the student. Much of the want of effectiveness in teaching these subjects arises from touching a subject too lightly. There is nothing for the student to bite, and ideas

[1] Chemistry should follow Heat and precede Electricity.

require to be fixed by working plenty of numerical examples.

Such instruction would enable students to make sound progress in the technical subjects, so far as these can be carried in a two or three years' course; but it can hardly be considered enough for those who propose to devote four or five years to study, and who may in all likelihood proceed to the Technical College. These will require a more extensive knowledge of the Mechanics of Solids and Fluids, Heat, Electricity, and Magnetism. As in the elementary course, the view is held that the treatment should be on the lines of systematic instruction in pure science, with frequent illustrations from the daily occupations of the students.

In regard to Chemistry, also, the more elementary part of it is better taught before the serious study of technical subjects begins. If the student is introduced to the subject by the usual experiments on the rusting and tarnishing of metals, he will be led to the composition and properties of air; the properties of oxygen and the common oxides; the composition and properties of water, and its suitability for industrial purposes; hydrogen and its properties; and the common materials and phenomena of every-day life. He will get some notions as to what is meant by chemical change, and obtain some acquaintance with the chief classes of inorganic substances. Incidentally opportunities will occur to deal with the best conditions for combustion and the nature of the products in an ordinary furnace; with the principles of metallurgical operations; with matters connected with founding and forging; with

the necessity and means of preserving metal work; and many other subjects of direct interest to the students. While they were insensibly being trained in observation and methods of inquiry, they would develop a keener interest in the things around them.

The question as to whether formulæ and equations should be introduced at this stage is not easy to decide. The alternative syllabus in Chemistry of the Board of Education in which formulæ and equations did *not* appear has frequently been recommended for technical students on that account. Such a view, however, ignores the prospect of the student's having any desire to proceed further privately, or to read technical literature. Writers of text-books and in technical journals have no qualms of conscience as to the use of formulæ and equations, and so long as the "chemist's shorthand" is employed so freely in all the sources of information to which the student may turn, it seems difficult to avoid the conclusion that even an elementary study of Chemistry—to be complete—should include some explanation of the symbolic representation of composition and reaction.

For students who desire to extend their studies over four or five years, further study would be desirable. The question will again arise as to whether highly specialised instruction or a more scientific treatment is to be followed. While there may be differences of opinion on this matter, it is probable that the latter course would be more suitable, especially if emphasis were laid upon those facts and principles which were of the greatest importance to the majority of the students. The instruction might include some of the important

facts of physical chemistry; a fuller discussion of combustion, especially in gaseous mixtures; explosives; and a general study of the common elements according to the periodic classification in which, while the general properties of the groups would be demonstrated, special attention would be paid to those substances of industrial importance. The time usually devoted to purely chemical manufacturing processes — sulphuric acid, alkalis, iodine, etc.—might be considerably curtailed. This plan seems to have an advantage over that in which Engineering students are recommended to join a class in Metallurgy, for two reasons. The more extensive study of the principles of Chemistry will be of great value to him in after life, and the details of smelting operations are of little interest to him unless he happens to be employed in a Metallurgical Works.

Before closing the discussion on Physics and Chemistry, it may be noted that in most cases the former subject can be taught to students in any of the trades considered without much difficulty, and that the same plan can be followed in Chemistry in the early stages. If, however, the latter subject is to be highly specialised, the students ought to be dealt with separately. The determining factor is the number of students from each trade who require instruction, and it is always difficult in evening work to avoid classes of mixed experience and aims. Where it can be effected with economy, the teacher's task may be lightened, and the educational progress of the students rendered more rapid, by grouping those engaged in the same or similar occupations.

In considering instruction in Machine Drawing and Building Construction there are several points of interest. No satisfactory progress can be made unless the students have had previous practice in the use of instruments and understand simple geometrical constructions. Where such preparatory training has not been received, very slow progress is made, and all preparatory courses involve the study of Geometry. Granted that the student is fairly adept in the use of instruments, it is important to have clear notions as to the object. Primarily the student requires to be taught to "read" drawings rather than to "make" them, in order that he may understand the drawings to which he has to work in the shops, or those which occur in his text-books and in technical journals. In other words, the first object appears to be the acquisition of facility in visualising a solid object from its flat representation. This end can be best attained by constantly associating the model or actual object with the drawing. A freehand dimensioned sketch should be made from the student's own measurements, and the scale drawing made from the sketch. In this way the student obtains some idea of the proportions, and a clear conception of the construction of the examples drawn.

Incidentally, the student who is taught according to the above method learns how to sketch in fair proportion, obtains practice in accurate drawing, becomes familiar with the materials used in construction, and the form which must be adopted to give the necessary strength or stiffness. These

observations will be far more real and permanent than can be secured by didactic instruction in construction.

In later stages of the work the use of models is of less importance, though they may be useful for demonstration. This does not mean, however, that the well-nigh universal practice of "copying" flat examples is correct at any period. But it seems desirable that the student should begin to use his observation and experience to execute simple designs. Close observation and inquiry will thus be stimulated, and the student will gain confidence, and develop resource and initiative. He will learn that while the proportions of many parts of constructive work must be determined by accurate calculation, those of other parts are largely dependent upon the judgment of the designer, and he will be introduced to questions of economy, which are so important in the present stress of industrial competition.

There is, in general, far too much time devoted to this subject in Evening Technical Schools, and much of the work done in class might equally well be done at home. A certain amount of facility in draughtsmanship is no doubt very useful, but to the majority of students drawing is a means rather than an end, and while many have to work to drawings, few are required to make them. Sketching, however, is of importance to all, both in actual work and in facilitating their progress in other subjects of instruction. The usual method of copying diagrams from a book, in which all the difficulties of representing a three-dimensional object on a flat surface have been

overcome—in what manner the student rarely learns—does not seem to be satisfactory. Little is gained in this way beyond a certain freedom in the use of the pencil, and some practice in copying outline. To sketch solid objects with any degree of accuracy requires a knowledge of the principles of Model Drawing, and this is best attained in the preparatory courses of instruction indicated in Chapter II.

The somewhat sharp distinction which has been drawn between the objects of the earlier and later stages of instruction in Machine Drawing and Building Construction appears to be equally applicable to Applied Mechanics and Steam. At first the student may be considered to be gaining familiarity with the applications of mechanical principles, with the properties of materials, and with the construction and mode of action of common machines. The object is, not to enable him to answer certain typical questions at the end of the session, but to excite curiosity and interest in the tools, machinery, and methods employed in the various trades. Meanwhile, the student is accumulating experience as to the why and wherefore of particular structural forms, mechanisms, methods, which provide material for "designing," should he have the capacity and the desire to proceed to the higher branches of these subjects. Difficulties may occur sometimes in selecting examples which appeal with equal force to all the students, who may be drawn from various industries; and slavish adherence to certain text-books may lead in some cases to much discouragement. A book which confined itself almost entirely to a detailed consideration of Marine Engines

might be admirable for students employed in a Marine Engineering Establishment, and quite unsuitable for others whose experience lay in a totally different class of work. To be effective, teaching cannot rely entirely on the work done in the class-room, but must stimulate reaction between the student and his environment.

Students in some industries may be said to require only certain portions of Applied Mechanics. Thus, for Building students a knowledge of Statics is of chief importance, while Mining students are more directly concerned with Pumping, Haulage, and the Transmission of Power. Neither class will be much interested in the principles of mechanism—in the theory of the various contrivances for communicating motion. How far special desires of this character should be humoured is probably an open question, and steps in this direction, however desirable, will always be limited by considerations of economy. It may be noted, moreover, that while a syllabus may appear much wider than a casual glance at immediate requirements may indicate to be necessary, it may be none too wide to ensure satisfactory progress in another subject which may have to be studied subsequently. This is illustrated by the case of the student who desires to obtain some knowledge of Steam, Gas, and Oil Engines. Unless the teacher of the latter subject is going out of his way to explain all sorts of mechanical contrivances, such a student can omit very little of the first stage of the Board of Education Syllabus in Applied Mechanics. It would be well if every student, no matter what industry he may be engaged in, so long as it involves the use of machinery, were

to aim at securing an elementary knowledge of both these subjects, before devoting his attention to a special section.

Wherever laboratories are available, it is most important that practical work should be done by the students in these subjects. Such work takes up a considerable amount of time, but this cannot be weighed against the benefits that accrue from a well-organised series of experiments. The closest possible connection between the lecture and laboratory work is desirable. It is in the laboratory that the student obtains at first hand a knowledge of the properties of materials, and the capability of machines; where he learns to adopt the habit of inquiry, and develops resource and initiative. And in Applied Mechanics, at any rate, the theoretical lesson is best devoted to a discussion, consolidation, and extension of the results obtained by the students in the laboratory.

The question as to whether the theoretical instruction should be based upon the student's work in the laboratory, or *vice versâ*, is not, in the early stages, a mere matter of opinion. If the latter is adopted, there is less value in the training, and a tendency to concentrate attention on obtaining a numerical result. For an elementary student to be told to "verify" an important "law" seems likely to give rise to a misapprehension as to the value of his own work, and to discredit the work of the great investigators who have preceded him. The whole attitude savours of downright impertinence. On the other hand, if the student has the subject presented to him as a series of problems, if he is encouraged to devise experiments for their solution with the simplest apparatus, he is

developing habits which will be of the greatest value to him in after life. As Sir Philip Magnus says:[1]

"No education is complete, however elementary soever it may be, which does not show us the methods by which knowledge has been created, and give us some training on their use."

The most important point to note in connection with Coal Mining is the number of subjects of both pure and applied science which are involved in the study. The Mining teacher has to refer from time to time to matters which are usually only fully discussed under the titles of Theoretical Mechanics of Solids and Fluids, Heat, Chemistry, Electricity, Geology, Applied Mechanics, and Steam. In addition, he must deal with methods of working coal, and with the precautions which must be observed in accordance with the Coal Mines Regulation Act. The students have only received, except in rare instances, an elementary school education. The teachers are practical men, who in very few cases have any special training in Engineering, and still less in fundamental scientific subjects. It is obvious that one man cannot give satisfactory instruction in such a composite subject. While admirably qualified, as a rule, to discuss methods of working, they have neither the time nor the training to give instruction in the subsidiary subjects which are essential to an intelligent understanding of the manifold operations involved in the economical production of Coal. The teaching, except in regard to the details of "getting coal," must be didactic; the knowledge largely empirical. Bearing in mind the nature of the subject, the

[1] "Industrial Education," p. 121.

qualifications of the teachers, and the general state of preparation of the students, it may be stated, with no little emphasis, that Technical Education for men who are to occupy responsible positions in this industry must provide for the widest possible scientific basis.

The necessity for a colliery manager or under-manager to possess a certificate of competency provides a stimulus that cannot be found in any other industry; but it is to be feared that this has not always been of a wholesome character. It is almost unavoidable that where an examination is regarded as an end rather than a means, there should be developed a desire to find a "royal road," and the educational value of study must suffer in consequence. This must be more serious when, as in the present case, the examiners are not necessarily in close touch with educational institutions, and are rarely acquainted with improvements in educational methods.

While the Home Office Examinations have done much to raise the standard of theoretical knowledge of colliery managers, their function in regard to Technical Education needs to be carefully defined. The test is a *minimum* test. Its aim is to secure that the men in charge of collieries shall be acquainted with present methods of working, and with the provisions of the Acts which have been passed to secure the safety of the men. The aim of Technical Education, on the other hand, is to secure that men who may become colliery managers shall possess such a knowledge of the principles underlying their own and cognate industries that they may be able

not only to carry out their duties in a satisfactory manner, but also to take advantage of new inventions and discoveries, and meet the ever-varying needs for new machines and new methods as they arise. The Home Office Examination is an incident in the Mining student's career—essential, it is true, but imposing no upper limit.

The most satisfactory results will be obtained, therefore, where the Mining teacher devotes himself to that part of the subject of which he has special knowledge, while the subsidiary but not less important subjects are taught by those who are more highly qualified to deal with them. The instruction may include the elements of Geology, with special reference to the carboniferous formation, and the consideration in detail of the operations of sinking, laying out, and working collieries. Detailed descriptions of plant will naturally be deferred until the student has a sufficient knowledge of Mechanics to appreciate the principles involved. As most of the students are engaged at the coal-face, and only indirectly concerned with machinery, this arrangement possesses a decided educational advantage. Moreover, problems of economy will be more readily grasped by the student who is older, and has a more extensive mind-content.

The question as to whether workshop instruction should be given in Evening Technical Schools is of importance, if only on account of the popular notion that the provision of a workshop makes any school into a technical school. Dealing first with Engineering workshops, it may be noted that they were originally introduced to enable Engineering subjects

to be illustrated to boys fresh from school who had no previous workshop experience. The students were shown how to forge, chip, file, and how to make patterns. In the time at their disposal, it is obvious that only a general knowledge of tools, materials and processes, and no great skill, could be obtained. When these workshops are thrown open to evening students, the avowed object in a number of cases is to supplement the somewhat meagre experience which falls to the lot of most apprentices owing to the extensive division of labour that obtains in the industry. The instruction varies from that indicated above as being given to day students, to the construction of a small engine or machine tool.

If the tendency in industry is to reduce the need for workmen of all-round skill, it is doubtful whether a mere repetition of the student's daily work falls within the scope of technical instruction at all. So far as skilled workmen are required, it seems reasonable to suppose that the managers of works will themselves see that the supply does not sink below the demand. The nature of a man's work is generally at their discretion, and they can, if they feel the necessity, give him a far more satisfactory training of this sort than any technical school workshop.

But if the need of skilled workmen has decreased, the demand for more exact knowledge of materials, processes, and tools on the part of foremen has increased, and the special syllabuses in Chapter IV. indicate a tendency on the part of technical schools to supply instruction suitable for men of this type.

The Leicester Syllabus (p. 90), in particular, seems to deal with knowledge that a man might spend

years in the shops without acquiring; and instruction of this sort, combined with a moderate knowledge of the scientific principles underlying the industry as a whole, would probably be of great value to those on whom the responsibility of controlling the workshop will devolve.

The next question that arises is, Can such instruction be adequately illustrated in school workshops, and if so, is this essential? To these questions it is not easy to give an answer. The writer, without laying any great stress on his opinion, would say "Yes" to the first and "No" to the second. The chief difficulty would probably be met in the small amount of time which the evening student can devote to the subject, and the fact that the execution of work in metal cannot be hurried. Where workshops exist it might be possible to arrange a series of exercises to illustrate the instruction, and in the absence of technical school workshops, useful demonstrations in the works—with the consent of the employers—might be given. The object would not be the acquirement of skill, but that wide knowledge which a man should have if he is to exercise control over a number of men engaged on different kinds of work.

It would be unwise to curtail the amount of time which those who aim at more important positions in the industry can spend upon theoretical subjects, for the sake of the somewhat doubtful advantage of a course in the Evening Technical School workshop, and no provision will be made for this in the major courses of instruction to be described later.

In regard to Building students, the same considerations will apply, and specific instruction in the "trade"

subject, with workshop practice where desirable, will be included only in the minor courses.

An important point in regard to the subjects discussed is their dependence upon one another. For satisfactory educational progress, it is necessary that they should be arranged in a rational order. Thus, in the case of steam and gas engines, the student will find far fewer difficulties if he has some previous knowledge of Heat, Chemistry, and Applied Mechanics. Chemistry itself is not an easy subject if the student has no preliminary knowledge of Heat, and Applied Mechanics is more readily appreciated by a student who has acquired clear conceptions of mechanical principles through a study of Experimental Mechanics. Finally, little progress can be made in any subject without an adequate knowledge of Mathematics and Geometry.

Again, Applied Mechanics, Steam, and Mining require that the student shall be able to understand drawings of machinery, and Machine Drawing presupposes a knowledge of at least the simple geometrical constructions and the elements of projection.

The various branches of Physics can be arranged in rational order among themselves. Mechanics can be taught successfully, up to a certain stage, to students who have a sufficient knowledge of Mathematics and Geometry, without the slightest reference to Heat or Electricity. The same cannot be said of Heat, which involves ideas of mass and density from the beginning; while Electricity and Magnetism is still more a derived subject, requiring, if clear concepts are to be obtained, a knowledge of Mechanics, Heat, and Chemistry.

If the subjects which have been discussed in this chapter are arranged in logical sequence, we get the order: Mathematics and Geometry, Mechanics, Heat, Chemistry, Electricity and Magnetism. Applied Mechanics comes level with Heat, and Steam level with Electricity and Magnetism. Machine Drawing may follow Geometry and precede Applied Mechanics, while Machine Design is really Applied Mechanics and Steam in a higher stage of development. From this point of view Mining is wider than any of the others, being the application of Engineering to the getting of minerals, and involving, therefore, a knowledge of Geology.

Of course, all this is perfectly well known, and it is an indisputable fact that progress is easier and sounder when the logical order of studies is obeyed. That the advantages of a proper arrangement of studies has been so completely ignored in Evening Technical Schools in the past is a matter of astonishment. Some parts of a subject can be taught as though it were completely independent; but ideas can never be so clear, the knowledge can never be so precise, as when due regard is paid to logical order. There can be no comparison between the rate of progress and the knowledge acquired by a first year student in Steam who has received appropriate preliminary training, and by a student who has not. Mathematics alone is of no avail; the mind-content of the pupil should be such as will render the assimilation of new ideas rapid and sure, and this mind-content can only be produced by a previous study of Physics and Applied Mechanics, accompanied by Machine Drawing.

If in addition to the rational order of subjects studied in successive years there could be judicious correlation between subjects studied concurrently, the capacity of students would be greatly increased. The best students naturally perform this correlation for themselves; but if there were an intelligent understanding between the teachers of different subjects—for which a plea has already been advanced—students of lesser calibre would find many of their difficulties removed. This is not providing a "lift" instead of a "ladder," but making the most of the material at hand. Evening students, as a whole, are little less capable than day students; they labour, however, under heavy disadvantages, and their attendance for study after a hard day's work shows that they possess not a few of the qualities that make for success in life. Just as the capacity of the electric field increases with the dielectric strength of the medium, so does the capacity of the Evening Technical School increase with the "educational atmosphere" that pervades the instruction. The students acquire knowledge and skill more rapidly at the same pressure.

CHAPTER VIII

COURSES OF INSTRUCTION

If students are to reap the full advantages of systematic courses of instruction, there must be some definite standard of admission. In towns—especially in Engineering classes—there is an increasing number of students who have been for three or four years at a Higher Elementary School, or for two or three years at a Secondary School. If to this fact is added the doubtful value of technical instruction in the case of students under sixteen or seventeen years of age, it does not seem extravagant to demand from all students the standard of attainment suggested in the preparatory course indicated in Chapter II., and more fully described as regards Physics and Chemistry in the last chapter. The following courses therefore involve the assumption that the students have such a knowledge of Mathematics and Geometry, Physics and Chemistry, on their admission to the Evening Technical School. It must be understood that these courses are not the only possible ones. Others could be arranged without departing from the logical order of subjects,

and experience alone can determine which is the most suitable for any particular conditions. They are to be regarded simply as illustrations of the way in which educationally sound, systematic, and progressive courses can be drawn up so as to involve no more time than the evening student can usually devote to study.

(a) *Mechanical Engineering.*

We may consider first the lower grade, in which the whole training has to be obtained in evening classes. The student will have left school at fourteen to fifteen years of age, and have spent two years in evening continuation or preparatory classes. The nature of the instruction required will be as follows:

(i.) Mechanical Drawing, so far as it is necessary to enable him to read working drawings.

(ii.) Applied Mechanics and Steam, to enable him to understand the machinery employed in the shops.

(iii.) Mathematics, to enable him to follow the instruction under (ii.), perform the ordinary calculations of the workshop, and read the literature of his own of the branch trade.

(iv.) Specific instruction in the principles more directly underlying his own branch of the trade, accompanied, where possible, by workshop illustration.

These subjects should cover three or four years, and should not require more than three or four nights a week. The following arrangement is suggested:

First Year	Second Year	Third Year
Mathematics and Geometry Machine Drawing Applied Mechanics (Theo. and Pract.)	Mathematics and Geometry Machine Drawing Special	Applied Mechanics (Theo. and Pract.) Steam (Theo. and Pract.) Special

If the work of the student involves the use of electrical machinery, the fourth and later years can be devoted to Electricity and Magnetism, and Technical Electricity. The special subject will be fitting and turning, forge work, pattern-making, foundry work, or boiler work; and the instruction in Machine Drawing should have regard to the nature of the industry in which the students are engaged. At the end of the third year, or, if a student is weak in one or two subjects, the fourth year, he should be able to pass the examination[1]

[1] The reference to examinations on this and the following pages is merely for the purpose of indicating the general standard of work at various stages.

in the ordinary grade of Mechanical Engineering under the City and Guilds of London Institute, and he should possess the Board of Education Certificates in the first stage of Practical Mathematics, Applied Mechanics, Steam, Geometry; and in the second stage, of Machine Drawing. Any further study should be accompanied by a corresponding strengthening of the general foundation. This course is probably most nearly followed at Salford. It differs mainly from that course in substituting Steam for the second stage of Geometry; in the provision of the preparatory course in which the student obtains sufficient knowledge of Experimental Mechanics and Heat to render his path easier in Applied Mechanics and Steam; and sufficient knowledge of Chemistry to enable him to get clear notions of combustion and the preservation of materials.

Dealing now with the higher grade, it may be observed that the difficulties are more serious. The instruction required covers a wide field, time is limited, and the student is not anxious to devote much of it to subjects which often do not appear to him to have direct application to his work. At the same time, it has been pointed out that specialisation on too narrow a basis is unsound educationally, and that continuity of the evening and day curricula should be kept in view. What, then, is the proportion of time that each subject should receive in order to preserve a balance of studies? The following table may help to solve the question. It indicates the number of hours which a day student devotes in the year to each subject,

or group of subjects, at eight typical Technical Colleges or Universities.

Colleges.	Mathematics.	Physics and Electrical Engineering.	Chemistry and Metallurgy.	Drawing.	Mechanics and Steam.	Workshop.	Total No. of Hours.
	Subjects.						
Manchester	200	200	200	240	100	100	1040
West Ham	170	270	170	60	170	160	1000
Bristol	180	180	140	320	70	180	1070
Bradford	160	85	35	255	—	660	1195
Swansea	100	240	270	100	70	100	880
East London	210	310	—	210	210	70	1010
Northampton Institute	190	190	100	140	160	160	960
Birmingham	120	150	190		420		880

Notwithstanding the fact that considerable differences are apparent, there is still much upon which the different schools agree. Departures from the mean are easily explained. Thus the Bradford course is distinctly framed to shorten the period of apprenticeship, and the course all through contains a preponderance of workshop practice. Parenthetically, the fact that strictly engineering subjects are omitted until nearly 700 hours have been spent in the workshops is not an unworthy argument in favour of the school-works-college view. The only school which does not include Chemistry

is that at East London. If a mean is taken of all the courses, a course will be obtained to which few objections could be raised.

The problem, then, is to determine an arrangement of subjects in a rational order which shall occupy not more than three evenings a week, and cover approximately the same ground as a day student does in an average course of instruction corresponding to those which have been set out. The following table is the result of many attempts to attain this object without departing from the syllabuses and hours of instruction that obtain in the majority of schools:

First Year	
Mathematics and Geometry	2½ hours.
Machine Drawing	2½ "
General Physics (Theo. and Pract.)	2½ "
Second Year	
Mathematics	2 hours.
Machine Drawing	2½ "
Heat (Theo. and Pract.)	2½ "
Third Year	
Mathematics	2 hours.
Applied Mechanics (Theo. and Pract.)	2½ "
Chemistry (Theo. and Pract.)	2½ "
Fourth Year	
Metallurgy (Theo. and Pract.)	2½ hours.
Steam (Theo. and Pract.)	2½ "
Electricity and Magnetism (Theo. and Pract.)	2½ "

The number of hours spent on each subject by a student following this course is compared below with the average amount of time spent by a day student in one year:

	Four Years, Evening.	One Year, Day.
Mathematics,	150	170
Physics,	225	200
Chemistry,	150	140
Drawing,	195	180
Mechanics and Steam,	150	110

The standard aimed at in each subject may be briefly stated, and one or two other matters discussed.

The Mathematics in the first year would cover the first stage of the "practical" syllabus, with additional trigonometry. Geometry would have its dual character recognised by treating Plane Geometry and Graphics in the hour and a half following the Mathematical lesson, from which it would frequently be inseparable, and associating the projection of solids with Machine Drawing. General Physics includes dynamics and properties of matter. In this way it is believed the well-prepared student would be able, at the end of his first year, to take the second stage examinations in Theoretical Mechanics, solids and fluids, and in Practical Plane and Solid Geometry, with the first stage examinations in Practical Mathematics and Machine Drawing.

The second stage examination in most subjects is usually considered to represent the test for at least two years' work. This is true enough in the case of an ill-prepared student taking a single subject; but it it does not apply to students who have a fair general

preliminary training, and whose studies are arranged in logical sequence, and with intelligent grouping.

The second year work leads to Stage 2, of Practical Mathematics, Machine Drawing, and Heat; the third to Stage 2 or 3 in Practical Mathematics, Stage 2 in Applied Mechanics and Chemistry; and the fourth year to Stage 2 in Electricity and Magnetism and Steam, and Stage 1 in Metallurgy. The latter subject might well be replaced by a course in Engineering Chemistry.

Of course, it is easy to criticise this scheme. Thus, in some courses which have been considered, two years are spent in the study of the elementary stage of Steam. For them, however, no preliminary standard is exacted, nor do they include a year's study of Heat, as the one above does. Again, none of the day Colleges teach Steam in the first year; it may be asked: Why, therefore, do it in evening classes, which are supposed to correspond? The course is a compromise. The student may not proceed to a day College. The introduction of Steam at that point is desirable in order to give a certain amount of completeness to the curriculum; and the main defect which required remedy, was the lack of breadth of studies in existing courses. The amount of time—about seven and a half hours a week—may appear excessive. On the other hand, the amount of time devoted to drawing or laboratory work in successive years is five and a half, four, three, and four and a half. Drawing is not exacting, nor is laboratory work, while it facilitates the attainment of clear notions, and diminishes the number of numerical examples that need to be worked. Still another

complaint—and probably a very general one—might be that Chemistry has been too generously treated. The subject is of much more importance than is usually admitted, and this importance is on the increase.[1] Moreover, it takes longer to permeate the average student than any other subject, and for this reason alone demands all the time that can be given to it.

The course provides a basis for specialisation, and the duration of four years has another significance. While the usual duration of apprenticeship is from the age of entry to twenty-one, the shortest period for a school-works-college pupil is generally fixed at four years. This coincides exactly with the course proposed, while the scope of studies enables the student to commence on the second year course on entering College.

Lest the plea of too much pure and too little applied science should be raised, the suggested curriculum may be compared with that for Apprentices in the Royal Dockyards. The number of marks attached to each subject is an indication of its importance.

First and Second Years.

Arithmetic and Mensuration -	400 marks.
Algebra - - - - - -	400 ,,
Geometry (Euclid I. to VI., XI. and XII.) - - - -	500 ,,
Trigonometry - - - -	500 ,,
Statics and Hydrostatics - -	600 ,,
Physics (Light, Heat, Electricity and Magnetism) - - -	600 ,,
Chemistry - - - - -	300 ,,

[1] See an article on "Chemistry in Engineering," by Dr. Wm. MacMurtrie, *Cassier's Magazine*, June, 1902, p. 509 *et seq.*

French (optional)	400	marks.
Geography and English History	400	„

Third and Fourth Years.

Statics, Hydrostatics, and Hydraulics	500	„
Dynamics	500	„
Applied Mechanics	500	„
Higher Algebra and Trigonometry and Elementary Conic Sections	500	„
Differential and Integral Calculus and Conic Sections	700	„
Descriptive Geometry (or Mechanism)	400	„
Physics (Light, Heat, Electricity and Magnetism)	700	„
Chemistry	400	„
Naval Architecture (or Engineering)	2,400	„

There is ample justification for the inclusion of Physics and Chemistry. The standard of admission is Arithmetic (except cube root), Algebra, including simultaneous and quadratic equations, Euclid I. to III., and the usual English subjects; the age is fourteen to sixteen years. This is not very different from that proposed for evening schools in this book: in Mathematics it is more extensive, but neither Physics nor Chemistry is required. It will be noted that all apprentices attempt this course, and some are weeded out at the half-yearly examinations. There is no attempt to supply in the school the specific instruction in the several branches. An apprentice is attached to an instructor, who is a skilled workman specially selected by the superior

officers of the dockyard for this purpose, and who receives two shillings a week extra in consequence. While this is an infinitely better arrangement than any that exists in private shops, it is open to question whether it is equal to specific instruction (say) on the lines of the Leicester Syllabus (p. 99). Of course, an apprentice can attend evening classes after he has left the dockyard school.

The system has turned out numbers of men who now hold the highest professional positions in the country,—such as the higher positions in the Admiralty, the Marine Department of the Board of Trade, Lloyd's Registration Society, and many private shipbuilding and engineering firms.[1]

(*b*) *Electrical Engineering.*

The only courses for the minor positions under this head appear to have been drawn up for those engaged in wiring. There must, however, be a considerable number of men who aim at becoming shop foremen, and for whom the major courses are too ambitious.

A suggested arrangement of subjects is given below:

First Year	Second Year	Third Year
Mathematics Drawing Applied Mechanics (Theo. and Pract.)	Mathematics Electricity and Magnetism (Theo. and Pract.) Special	Applied Mechanics (Theo. and Pract.) Technical Electricity (Theo. and Pract.) Special

[1] *Cassier's Magazine*, November, 1902, p. 205 *et seq.* *Technics*, January, 1904, p. 58.

The scope of each subject will be sufficiently apparent from what has been already said.

The major course in Electrical Engineering need differ in no important respect from that for Mechanical Engineering. The electrical engineer is quite as much concerned with the properties of materials, the methods of mathematics and geometry, the fundamental principles of physics, the theory of mechanisms, as the mechanical engineer, and the first year courses of instruction at nearly all the day Colleges are common to both.

(c) *Building.*

The main sub-divisions of the Building trade for which minor courses are required are Carpentry and Joinery, Bricklaying, Masonry, and Plumbing. As plasterers' and painters' and decorators' work are in part Art crafts, they are outside the scope of this book.

For carpenters and joiners, the following three years' course is suggested:

First Year	
Mathematics and Geometry - - -	$2\frac{1}{2}$ hours.
Building Construction - - - -	$2\frac{1}{2}$ "
Applied Mechanics - - - - -	$2\frac{1}{2}$ "
Second Year	
Mathematics and Geometry - - -	$2\frac{1}{2}$ hours.
Building Construction - - - - -	$2\frac{1}{2}$ "
Carpentry and Joinery (Theo. and Pract.)	$2\frac{1}{2}$ "
Third Year	
Special Drawing - - - - - -	$2\frac{1}{2}$ hours.
Carpentry and Joinery (Theo. and Pract.)	$2\frac{1}{2}$ "

This differs from the course at St. Helens in the substitution of Applied Mechanics for Theoretical Mechanics, and in prescribing two years for Building Construction. The principal reason for preferring the applied subject is its bearing upon machinery which is so largely used in the trade. The Special Drawing in the third year would include projective geometry and setting-out. If machinery were largely used in the neighbourhood, a further course in Applied Mechanics would be desirable in that year.

A minor course for bricklayers and masons is given below:

First Year	
Mathematics and Geometry - - -	2½ hours.
Building Construction - - -	2½ ,,
Chemistry of Materials - - -	2½ ,,
Second Year	
Mathematics and Geometry - - -	2½ hours.
Building Construction - - -	2½ ,,
Brickwork or Masonry - - -	2½ ,,
Third Year	
Brickwork or Masonry - - -	2½ hours.

No stress is laid on Chemistry in the first year, because, except in the larger centres, it is unlikely that the number of students would justify its provision.

For plumbers, a suitable course would be:

First Year	
Mathematics and Geometry	$2\frac{1}{2}$ hours.
Building Construction	$2\frac{1}{2}$ "
Hydrostatics and Heat	$2\frac{1}{2}$ "
Second Year	
Building Construction	$2\frac{1}{2}$ hours.
Chemistry of Plumbing	$2\frac{1}{2}$ "
Plumbing (Theo. and Pract.)	$2\frac{1}{2}$ "
Third Year	
Plumbing (Theo. and Pract.)	—
Hygiene	—

The special aim in each of these schemes is to provide a progressive and educationally sound course of instruction leading up to the Honours Examination of the City and Guilds of London Institute. Those portions of the syllabuses which deal more especially with underlying principles are removed, and the appropriate science subject substituted. This leaves the trade teacher more time to devote to his own special part of the subject. Where a suitable syllabus does not exist, a special course has been indicated. The City and Guilds have for many years required students to possess certificates in certain subjects of science before the full technological certificates were granted. Unfortunately, students have often taken the Honours Certificate in the trade subject *first*, and then cast about for the easiest subjects which would

give them the full qualification. In this way not only has the rational order of study been frequently reversed, but owing to want of system in the organisation of schools, an unhappy choice has been made in the science subject. The introduction of a preliminary grade in certain subjects has obviated this difficulty to some extent, and though exception might be taken to the standard of the examination in particular cases, the principle cannot be too highly commended.

Major courses in Building are probably only required in the larger towns. Those who require them are Architects' pupils and others who aspire to become master-builders on a fairly large scale. As the courses given on pages 137-40 differ considerably from one another, an attempt has been made to combine the good features of all. In view of the fact that so few Colleges arrange day courses for this trade, no attempt has been made to fit it in with any day course.

First Year	
Mathematics and Geometry - - - -	2½ hours.
Building Construction - - - -	2½ ,,
Chemistry (Theo. and Pract.) - - -	2½ ,,
Second Year	
Mathematics and Geometry - - - -	2½ hours.
Building Construction - - - -	2½ ,,
Applied Mechanics - - - - -	2½ ,,

Third Year	
Mathematics - - - - - - -	2 hours.
Building Construction - - - - -	$2\frac{1}{2}$,,
Applied Mechanics - - - - - -	$2\frac{1}{2}$,,
Fourth Year	
Mathematics - - - - - - -	2 hours.
Building Construction - - - - -	$2\frac{1}{2}$,,
Builders' Quantities - - - - -	—
Architecture - - - - - - -	—
Fifth Year	
Building Construction - - - - -	$2\frac{1}{2}$ hours.
Builders' Quantities - - - - -	—
Architecture - - - - - - -	—

(*d*) *Coal Mining.*

A glance at the courses on pages 148-9 will show that considerable doubt exists as to what should or should not be included in a curriculum adapted to this industry. The present aim of all Mining classes is to prepare the student for the first and second class colliery manager's certificates. The *raison d'être* of such certificates is to secure that collieries shall not be placed in charge of incompetent men—to secure that they shall be managed by men whose knowledge of the Coal Mines Regulation Act, and the usual method of working in the district, shall ensure that the danger to life and limb shall be the least possible. These qualifications are so easily obtained by men

whose length of experience compensates for deficiencies of early education, that they do not command the respect they should from colliery agents.

The courses given below are drawn up on a more liberal interpretation of requirements.

Minor Course

First Year	
Mathematics and Geometry - -	$2\frac{1}{2}$ hours.
Mining and Drawing - - - -	$2\frac{1}{2}$ "
Applied Mechanics (Theo. and Pract.) -	$2\frac{1}{2}$ or 2 hrs.
Second Year	
Mathematics and Drawing - - -	$2\frac{1}{2}$ hours.
Mining and Steam - - - - -	$2\frac{1}{2}$ "
Electricity and Magnetism (Theo. and Pract.)	$2\frac{1}{2}$ "
Third Year	
Mining - - - - - - - -	2 hours.
Applied Mechanics - - - -	$2\frac{1}{2}$ or 2 hrs.
Technical Electricity (Theo. and Pract.) -	$2\frac{1}{2}$ hours.

Major Course

First Year	
Mathematics and Geometry - - -	$2\frac{1}{2}$ hours.
Mining and Drawing - - - -	$2\frac{1}{2}$ "
Heat - - - - - - -	$2\frac{1}{2}$ "
Second Year	
Mathematics and Geometry - - -	$2\frac{1}{2}$ hours.
Mining and Drawing - - - -	$2\frac{1}{2}$ "
Chemistry - - - - - -	$2\frac{1}{2}$ "

Third Year	
Mathematics	2 hours.
Mining and Surveying	$2\frac{1}{2}$,,
Applied Mechanics	$2\frac{1}{2}$,,
Fourth Year	
Mining and Surveying	$2\frac{1}{2}$ hours.
Electricity and Magnetism (Theo. and Pract.)	$2\frac{1}{2}$,,
Steam	$2\frac{1}{2}$,,
Fifth Year	
Mining	—
Technical Electricity	$2\frac{1}{2}$ hours.
Applied Mechanics	$2\frac{1}{2}$,,

The aim here is to give the student such a grinding in scientific principles as will ensure his ability to understand his own subject to the extent that his position in the industry demands. The minor courses would in all probability be held in smaller places, where laboratory work could not be undertaken. In such circumstances, more time would be given to the working of numerical exercises. The necessity of the instruction in Mining being accompanied by instruction in Drawing and Sketching is based upon the writer's experience of Mining classes, and it receives strong support from Professor le Neve Foster's Report on the Examination in the Principles of Mining for 1903.[1] The instruction in Mining would in all cases include the Geology necessary.

[1] "Board of Education: Reports of the Examiners on Results of Science Examinations," 1903.

It is of interest to compare the major course with that of the first year for the Diploma of University College, Cardiff. The standard of admission for the latter, it may be noted, is English Composition and Algebra to simple equations.

Subjects.	No. of Hours in	
	1 Year—Day.	4 Years—Evening.
Mathematics - -	—	120
Physics - - -	—	150
Chemistry - - -	110	75
Drawing - - -	—	150
Mining and Geology -	260	180
Surveying - - -	100	60
Engineering - -	60	150

Without seeking to inquire why the Cardiff scheme leaves out Mathematics and Physics, and includes a considerable amount of Chemistry, it will be profitable to suggest a less ambitious course for evening classes, which involves no previous knowledge beyond that of the Seventh Standard of an elementary school, and which, by involving attendance on only two nights a week, will be more convenient for a greater number of students.

First Year	
Mathematics and Geology - - -	$2\frac{1}{2}$ hours.
Mining, Mechanics and Heat - - -	$2\frac{1}{2}$,,
Second Year	
Mathematics and Machine Drawing -	$2\frac{1}{2}$ hours.
Mining, Heat and Chemistry - - -	$2\frac{1}{2}$,,

Third Year	
Mathematics and Applied Mechanics -	$2\frac{1}{2}$ hours.
Mining, Electricity and Magnetism -	$2\frac{1}{2}$,,

Fourth Year	
Mine Surveying and Steam - -	$2\frac{1}{2}$ hours.
Mining and Technical Electricity - -	$2\frac{1}{2}$,,

The discussion on Mining courses may be appropriately closed by the subjoined table, which manifests in a striking manner the uncertainty that exists in regard to the balance of studies for students engaged in this industry:

Subjects.	1 year Cardiff Diploma	1 year Sheffield.	1 year Birmingham Degree.	3 years Minor Course —Evening, p. 261.	4 years Major Course —Evening, p. 261.	4 years Alt. Course—Evening, p. 263.
Mathematics - -	—	180	120	60	120	60
Physics - - -	—	—[1]	—[2]	150	150	30
Chemistry - - -	110	150	270	—[1]	75	30
Mining and Geology -	260	120	150	120	180	210
Engineering and Drawing - - -	60	420	—[3]	250	300	150
Surveying - - -	100	—	60	—	60	30

[1] One hour a week in the second and eight hours a week in the third year are devoted to Electricity and Electrical Engineering.

[2] Eleven hours a week devoted to Physics in second year.

[3] Fourteen hours a week devoted to Engineering in second year.

[4] Preliminary knowledge assumed.

(*e*) *Metallurgy*.

This industry, in common with all other chemical industries, differs in several important particulars from those which have been just considered. In no other is there such a sharp contrast in the training required by the skilled and—relatively—unskilled workers, and for the lower grades hardly any attempt has been made to provide instruction. Quite apart from this contrast, there is the point already noted that such industries are the meeting-ground of the chemist and the engineer. Lastly, the tendency of each works to deal in a particular group of products renders specialisation necessary, and increases the difficulties of organisation.

For the minor course the following scheme seems to be suitable:

First Year	Second Year	Third Year
Mathematics and Drawing Chemistry (Theo. and Pract.) Metallurgy (Theo. and Pract.)	Mathematics and Drawing Metallurgy (Theo. and Pract.) Applied Mechanics (Theo. and Pract.)	Metallurgy (Theo. and Pract.) Applied Mechanics (Theo. and Pract.) Steam

The Drawing in the first and second years should be a special course, and should include simple brick-work and masonry, structural ironwork, cranes, etc., and should lead up to the drawing of furnaces, and the usual equipment of metallurgical works. Metallurgy in the second and third years should deal

mainly with the group of metals produced in the neighbourhood of the school. For students engaged in iron and steel works, the syllabus of the City and Guilds for "Iron and Steel" would be appropriate.

In the higher grade two classes of men have to be dealt with: metallurgical chemists and metallurgical engineers. In the day Colleges little or no distinction is made between the two; the course at the Manchester School of Technology, however, is admirably balanced. As the great bulk of evening students are definitely attached to one side or the other, two courses are suggested below.

Chemistry

First Year	
Mathematics and Drawing - - -	$2\frac{1}{2}$ hours.
Chemistry (Theo. and Pract.) - - -	$2\frac{1}{2}$,,
Heat (Theo. and Pract.) - - - -	$2\frac{1}{2}$,,
Second Year	
Mathematics and Drawing - - -	$2\frac{1}{2}$ hours.
Chemistry (Theo. and Pract.) - - -	$2\frac{1}{2}$,,
Metallurgy (Theo. and Pract.) - - -	$2\frac{1}{2}$,,
Third Year	
Mathematics and Drawing - - -	$2\frac{1}{2}$ hours.
Chemistry (Theo. and Pract.) - - -	$2\frac{1}{2}$,,
Metallurgy (Theo. and Pract.) - - -	$2\frac{1}{2}$,,

Fourth Year	
Electricity (Theo. and Pract.) - - -	2½ hours.
Chemistry (Theo. and Pract.) - - -	2½ "
Metallurgy (Theo. and Pract.) - - -	2½ "
Fifth Year	
Chemistry (Theo. and Pract.) - - -	2½ hours.
Metallurgy (Theo. and Pract.) - - -	5 "

Engineering

First Year	
Mathematics and Drawing - - - -	2½ hours.
Chemistry (Theo. and Pract.) - - -	2½ "
Heat (Theo. and Pract.) - - - -	2½ "
Second Year	
Mathematics and Drawing - - -	2½ hours.
Metallurgy (Theo. and Pract.) - - -	2½ "
Applied Mechanics (Theo. and Pract.) -	2½ "
Third Year	
Mathematics and Drawing - - -	2½ hours.
Metallurgy (Theo. and Pract.) - - -	2½ "
Steam (Theo. and Pract.) - - -	2½ "
Fourth Year	
Machine Drawing - - - - -	2½ hours.
Metallurgy (Theo. and Pract.) - - -	2½ "
Electricity (Theo. and Pract.) - - -	2½ "
Fifth Year	
Applied Mechanics (Theo. and Pract.) -	2½ hours.
Steam (Theo. and Pract.) - - -	2½ "
Technical Electricity (Theo. and Pract.) -	2½ "

It is assumed that electro-metallurgical methods are *not* in use in the industries for which provision is being made. The Drawing is on the same lines as in the minor course for the first three years; in the fourth year it would correspond to the second or higher stage of the Board of Education Syllabus. After the second year, the word Metallurgy is used to indicate a specialised course in iron and steel, or any other special course of instruction bearing upon the local industries.

The examples of systematic courses of instruction given in Chapter IV. were mostly drawn from those carried out in large towns, where the organisation has reached greater perfection than in the smaller centres of population. There seems to be no inherent reason—there may be difficulties in the way—why such systematisation of work should not become general in regard to the trades which have been dealt with. In many of the smaller towns classes in Machine Drawing, Building Construction, Mining, etc., are held year after year with but slight fluctuations in numbers, which might be organised into really efficient evening technical courses.

The really important thing to secure is a guarantee of stability in the numbers attending, and this, as has been noted, seems likely to be achieved through the enlightened attitude of employers of labour. An increase in the thoroughness of the instruction will react on the attitude of the employers, encouraging those who are backward, and so increasing the stability of attendance. The movement once commenced, the rate of progress would be rapid owing to the double acceleration.

While special difficulties which present themselves will be dealt with in the next chapter, two or three may be fitly discussed here. The first is the lack of agreement upon the essential components of a suitable educational course, and is well illustrated in the different character of the courses mentioned in Chapter IV. It is a serious difficulty, no doubt, but not an insuperable one. Much of the diversity is due to the accidents of equipment and staffing, which were provided before the object was fully considered; *much more to the fact that the most effective curriculum, as a whole, has rarely been thoroughly worked out.* The single subject has been the unit of organisation instead of the course. If attention is concentrated on the evolution of satisfactory courses, and if there is reasonable co-operation between the various educational agencies, most of the differences would disappear.

The second difficulty is the disinclination to constrain students to follow a course which has been carefully adapted to their needs, but from which the element of choice by the individual has been eliminated. Undoubtedly there are cases in which instruction in one subject may be beneficial to an individual, and no difficulty should be placed in his way; but the main object of the school should be carefully organised courses of instruction, with a definite aim to the improvement of the industries of the locality, and no individual benefit should be allowed to interfere with its successful operation. The curriculum should be sound, well-balanced, of direct value, and progressive. Differences may occur, but not on essentials; and such a fair uniformity of standard

at each period in courses bearing upon the same industry should be maintained as shall facilitate continuity of study by those who change their situations, and secure more than local recognition among employers. Some elasticity is essential in order that the instruction may keep pace with the ever-changing conditions of industry, but that elasticity need not materially affect the standard. *The main point is that the school should be organised for students who follow a course; that so far as they are concerned, the single subject should not exist. They join the school, and not one or other of the classes.*

There is no real difficulty in the fact that some of the examinations of the Board of Education and the City and Guilds of London Institute are in specialised sub-divisions, and others demand a knowledge of the whole industry. These sub-divisions are the bricks of the course, and the examinations allow of a ready means of testing individual bricks, whereas an examination on the industry tests the structure as a whole. Each examination has a perfectly definite function in testing the progress of the students in their study of the general principles underlying the industry as a whole, and in the principles which are applied to special branches. There must be some means of determining the promotion of a student from year to year. This may be wholly or partially based on the results of an examination either by a local or central authority. The examination by a central authority is necessary to secure uniformity of standard, and the element of uncertainty which is almost inseparable from a three hours' test of a session's work, coupled

with the likelihood that there can be no central examination for highly specialised subjects, renders it desirable that some other factors should have weight in the selection. The plan proposed on page 61, in which due regard is paid to habits of punctuality and industry, as well as to ability to satisfy a central examining body, seems to offer the greatest security for sound progress.

The titles of component subjects correspond in most cases to those of existing examination schedules. While these sufficiently indicate the scope of each component, they do not obviate the necessity of teaching syllabuses. Objections to much of the teaching at the present time are due not so much to faults in examination schedules as to their use in place of teaching syllabuses. The schedules issued by central authorities are useful as guides, but the exact order and method of instruction must be determined by a careful estimate of the object of the instruction to those who are to receive it.

CHAPTER IX

SOME SPECIAL PROBLEMS

I.—*Teachers.*

ONE of the first problems of technical education which should engage the attention of local authorities is the provision of teachers. The scarcity of really qualified men available to give instruction in certain essential subjects would hardly be credited by those who have not been under the necessity of looking for them. A man was required some time ago to teach engineering subjects, and though the county was searched for twenty miles round, amongst a population of nearly 200,000, only two were discovered who could conduct classes in Machine Drawing. Neither of these could undertake to give instruction in Practical Plane and Solid Geometry, Applied Mechanics, or Steam.

The majority of teachers of the above-named subjects in evening classes depend for their qualification upon the possession of a certificate in the second or a higher stage obtained at the Examinations of the Board of Education. It will be of interest to see how the above statement as to the scarcity of qualified men is borne out by the

numbers who pass the examinations. The figures in the table given below refer to 1903.

Subjects.	Honours Part II. First.	Honours Part II. Second	Honours Part I. Pass.	Advanced. First	Total.
Geometry - -	1	8	35	153	197
Machine Drawing -	1	5	64	581	651
Building Construction - - -	7	4	98	427	536
Applied Mechanics -	—	6	31	158	195
Steam - - -	1	11	83	132	227

If we assume that the same proportion of successful candidates will become teachers, it follows that for every class in Geometry with a qualified teacher there will be approximately three classes in Machine Drawing, and the same number in Building Construction, while for every class in Applied Mechanics there will be two classes in each of those subjects.

As there are districts in which there have been no classes in the advanced stages of Applied Mechanics, Geometry, or Steam for some years, though there are a hundred students annually in Machine Drawing, the scarcity of teachers in the first-named subjects must be serious.

The majority of the successes in the higher stages of these subjects must be obtained in those districts which are already supplied with well-qualified teachers. This fact has a two-fold effect. Not only are many students of Machine Drawing and Building

Construction deprived of instruction in subjects which would be of the greatest value to them, but the teachers of these subjects must lack an important part of their equipment. The essential interdependence of subjects renders it most desirable that a teacher should not only have adequate knowledge of the subject in which he gives instruction, but possess a fair knowledge of cognate subjects.

Moreover, if it were possible to distinguish technical students from others, the result of a similar investigation in regard to Chemistry and Physics would show that the general scientific grounding must be lacking in a very large number of instances. The teaching under such circumstances lacks breadth and thoroughness, and unless an effort is made to develop instruction in those subjects in which instruction is not so widespread as its importance demands, the evil will increase with the lapse of years.

In view of the opinion which has been expressed that many students require instruction in the principles of their craft, as well as instruction in the general scientific principles underlying the industry, it will be profitable to inquire into the number of teachers of technology available in regard to the trades considered. The figures given opposite are taken from the programme of the City and Guilds of London Institute for 1904-5.

Two points revealed by the above table call for special comment. The first is the small number of teachers and classes in Boilermakers' Work, which seems out of all proportion to the requirements of this branch of Engineering industry. The second is the large proportion of teachers in Building Trades

classes who live in London. This is particularly noticeable in the case of Brickwork and Masonry.

Generally speaking, there are fewer classes in technology than in the corresponding subjects of science, and though this is to be expected, perhaps, in that it is only within the last few years that grants could be obtained from the Board of Education for City and Guilds subjects, the disparity is of considerable importance.

Subjects.	No of Registered Teachers	No Teaching a Registered Class during Session 1903-4.	No. Living in London.	No. Teaching Registered Classes in London.
Boilermakers' Work	3	3	1	1
Carpentry and Joinery	187	89	42	19
Brickwork and Masonry	69	32	23	12
Plumbing	140	78	31	29
Builders' Quantities	35	26	10	5
Iron and Steel Manufacture	32	15	2	0
Mine Surveying	25	10	—	—

It is not possible to say what proportion of Building Construction students receive instruction in the appropriate trade subject, or *vice versâ*, but as a rule, classes in Building Construction are composed chiefly of carpenters and joiners. The number of *schools* in which Building Construction was taught in 1902-3 was 447, and grant was paid on 11,470 students, which is probably not more than 60 per cent. or 70 per cent. of the number under

instruction. In the same year the number of students in registered classes in Carpentry and Joinery was 3,536, so that if, as has been suggested, most Building students require special instruction, an increase in the number of teachers of Technology is necessary before systematic courses for this industry could be very greatly extended. It may be useful to give the corresponding figures for the other branches of the trade:—

Number of students under instruction in Plumbing - - - - -	3,253
Number of students under instruction in Brickwork - - - -	864
Number of students under instruction in Masonry - - - -	623

In regard to Builders' Quantities and Iron and Steel Manufacture, the supply is probably more nearly equal to the demand; but there must be a considerable number of classes in Mine Surveying taught by men who are not registered under the Institute.

Having shown the necessity for an increase in the number of teachers of certain subjects of Science and Technology, we may next proceed to consider methods of obtaining them. The institution of systematic courses of instruction would in time produce a large number of men possessing the requisite general and special knowledge. Much might be done immediately if the local authorities were to establish central classes in the more important subjects, and were to offer special facilities to students to attend them. Those

who completed the course and passed the examination might be reimbursed their fees and travelling expenses. Such a scheme has greatly increased the supply of manual instructors. If care were taken in selecting students of good general education and some aptitude for teaching, and if these classes were held twice a week for a year or two, the whole complexion of affairs would be altered.

In order that proper correlation may exist between subjects, it is often desirable that one teacher should be responsible for instruction in more than one subject. In the case of subjects under separate teachers, correlation may be effected if each teacher has some knowledge of the other man's subject. To secure this, teachers of Mathematics might be encouraged to qualify in Geometry; teachers of Building Construction in Carpentry and Joinery, or Brickwork and Masonry and Geometry; teachers of Machine Drawing in Applied Mechanics, Steam, Practical Geometry, and Practical Mathematics; teachers of Mining in Practical Mathematics, Applied Mechanics, Steam, and Geology. Some instruction in Sketching on the blackboard would be useful for all. In time there would be a well-qualified body of local teachers, who are generally preferable to the itinerant teachers. The latter are rarely in close touch with the students, still less with local employers and local industries. If the travelling teacher is to be a success in anything beyond pioneer work, he must be a man of exceptional ability; and it is fortunate that such men are occasionally to be found.

The difficulties of securing the services of a teacher of technology in smaller and somewhat isolated towns

might be solved in another way. A local employer might be willing to find suitable employment for such a man who could undertake to give instruction on two or three evenings a week. A case is known to the writer in which an offer of this sort was made, and an extension of the idea will be suggested later.

Before leaving the question of improvement in the supply and qualification of teachers, reference may be made to the academic character of much of the instruction in Chemistry and Physics. These subjects are generally in the hands of teachers who are graduates, and who rely on their University training as their qualification for giving instruction. So far as the teaching of Chemistry and Physics as Chemistry and Physics is concerned, the qualification is admirable. But in the greater number of Evening Technical Schools these subjects are only subsidiary subjects in a course, and require to be largely illustrated by reference to the industry in which the student is engaged. It is intensely disappointing to an evening student who has yielded to advice, and joined a class in one of these subjects, to find that a whole session's work leaves him no whit the wiser as to why the advice was given to him. The series of lessons may have afforded many opportunities for explaining the theory of operations which would otherwise be obscure to the Engineering, Mining, or Building students attending. Yet such opportunities may be neglected owing to the teacher's want of familiarity with the applications of the sciences of which he has mastered the theory.

The difficulty could be partly overcome by the co-operation of the scientific and technical teachers.

The teacher of pure science can easily ascertain what is required of him by consultation with the teachers of Engineering, Mining, and Building. Much profit, moreover, would result if teachers of Physics and Chemistry were to read the books used by their students in Applied Science. Many hints in regard to the application of Physics could be obtained from books on Applied Mechanics and Steam, and in regard to the applications of Chemistry,[1] from books on Mining, and the chapters on "Materials" in books on Applied Mechanics and Building Construction.

The references to methods of teaching which have occurred from time to time in previous chapters will have paved the way in some measure for a discussion of the next problem: The training of teachers for the special work of the Evening Technical School. The writer is fully prepared to be faced with the statements that such training is neither necessary nor practicable. An argument which might be raised is that the students in evening classes have reached "the age and standard at which the scholar becomes a student," and "acquires rather than receives." And from analogy with University Colleges and similar institutions, it might be urged that under these circumstances the artifices of the teacher are of less importance, since the students are old enough and sufficiently far advanced to rely on their own resources. While denying most emphatically that the "lecturing" of the University professor is

[1] Further information can be obtained from Blount and Bloxam's "Chemistry for Engineers and Manufacturers," Phillips' "Engineering Chemistry," and Sexton's "Chemistry of the Materials of Engineering."

necessarily conducted according to educational principles—though in individual instances this may be the case—it will be profitable to consider how far the assumptions as to age and standard are justified. Out of 657,000 students under instruction *in all kinds* of evening schools during the session 1902-3, 22 per cent. were between twelve and fifteen years of age, 53 per cent. were between fifteen and twenty-one, and 25 per cent. were over 21.[1] Thus about half the students in evening schools are not above the age of the pupils at secondary schools, the limits of age in which may be taken as eight to eighteen years. Now, in the case of the Universities it is generally admitted that the younger students, who are never less than sixteen, find the greatest difficulties in following lectures. In this connection the evidence of Professor Fleming is important.[2] These difficulties must be due in great measure to immaturity of mind; the idea that it may be due to the sudden transition from "teaching" to "lecturing" is hardly borne out when it is recalled that in the higher forms of secondary schools the student is left more and more to his own resources.

Consider next the standard of the work in Evening Technical Schools. In the majority of cases the student is *introduced* to the subject, and it is at the initial stage where the greatest difficulties occur, and where it is of the greatest importance that accurate conceptions shall be formed. Once a student has obtained preliminary notions, his progress is more rapid; he can rely more upon

[1] Report of the Board of Education for 1903-4, p. 61.

[2] See page 17.

himself, and requires the services of a teacher to a smaller extent.

There is still another argument in favour of more careful attention to method. The evening student can only devote from one-fourth to one-fifth of the time to study that can be afforded by those who attend the day College; it is undesirable that he should suffer the disadvantage which must ensue if he follows a narrower curriculum; and if good progress is to be made, this demands all the skill that a good teacher can bring to bear upon the instruction.

If we agree, then, that training can improve methods of teaching, and that the age, standard, and circumstances of evening students render it essential that no effort should be spared in securing efficiency of instruction, it is important to consider how this may be attained. It will be convenient to consider those who are not professional teachers and those who are professional teachers separately. In the first class are to be found men of every type, from the man with a genius for teaching, a master of his subject and the method of imparting it, whom no training could improve, to the man who, having acquired a limited knowledge of a subject, is diligently trying to impart it to others, but failing from want of general culture, and conception of what teaching really means.

If the student is to follow courses of instruction, these differences will lead to his greater progress in some subjects than in others, and, it is to be feared, would seriously affect his regularity of attendance and reduce the educational advantages to be derived

from systematic instruction. To remove these differences, the teachers might be encouraged to attend a course of lessons on the object, scope, and methods of Technical Education in evening schools, and on the method of presenting and illustrating a subject to a class, with some elementary explanation of the way in which a student acquires knowledge and skill. If the instruction in these matters was treated practically, and adapted to the capacity of those for whom it was intended, it would be of great value in raising the efficiency of their teaching. As to the encouragement to be offered, the local authorities might give preference in appointment and in salaries to those who availed themselves of the opportunities for professional study thus afforded.

As practical men are apt to doubt the efficacy of method, and the necessity of such training, it may be useful to give an example or two of what has been done in this matter. A course of instruction for teachers of Coal Mining has been arranged at University College, Sheffield. It consists of two classes on Saturdays, from 4.30 to 6 p.m., and 6.30 to 8 p.m., as follows:

(*a*) "Criticism Lessons," with practice in teaching, conducted under the supervision of a "Master of Method."

(*b*) Demonstration Work, with practice in making and setting up apparatus, and exercise, practical illustration of simple Chemical and Physical Phenomena.

The idea of the first portion is excellent, but the utility of the second may be an open question. Reasons have been given (Chapter VII.) for the belief

that the scientific instruction should generally be separated from and precede technical instruction. It would be unfair, however, to condemn the scheme in the absence of more detailed knowledge of the general education and scientific knowledge of the teachers in training, and the conclusion in any case would be determined by the critic's conception of teaching, and of the objects at which the instruction should aim. The experiment is of interest and importance.

Another example has occurred in Manchester, where the manual instructors have requested the Department of Education in the University to arrange for them a course of lectures on Method.[1]

Turning now to the question of special training for those who are professional teachers, we are perhaps on more debatable ground. There are thousands of elementary and secondary schoolmasters engaged in evening schools. All elementary school teachers have undergone some sort of apprenticeship, and have received instruction in the objects and methods of teaching the subjects that find a place in the curriculum; and now that evidence of having passed through a course of instruction in the theory and practice of education is required from those who desire

[1] A question may arise as to the provision of men to conduct these central classes. Two methods seem to be open. The first would be to encourage good technical teachers to go through a systematic course of instruction in the theory and practice of teaching. The other would involve the acquisition of workshop knowledge by men who were trained teachers. Which was the more suitable, experience alone could tell, and much would depend on the type of individual selected.

to have their names enrolled on the Register of Teachers, there is an increasing number of secondary teachers who possess some knowledge of the theory and practice of their profession, so far as it concerns the schools in which they are engaged. It is pertinent to inquire whether this training is sufficient to enable them to carry out in the most efficient manner a most important part of their duties.

The training of the staffs of the Educational Departments of the Universities is generally literary, occasionally and in part scientific, never industrial or technical. The specific instruction deals with the subjects of typical day school curricula, and with the manner of teaching them to boys between the limits of age usually found in such schools. The subjects of the Evening Technical School, and the aims to be kept in view in dealing with technical students, are disregarded.

It is a patent fact that such teachers find difficulties in giving instruction to students whose aims and needs are but vaguely known to them, and as the number engaged in this work shows no likelihood of decreasing, it seems reasonable to suggest that their professional training should do something to fit them for the work. The object might be accomplished in part by attendance during the period of training of a short course of lectures on the "Scope, Method, and Aims of Technical Education in Evening Schools." The instruction ought to be in the hands of a man with industrial experience, as well as adequate knowledge of the Theory and Practice of Education. Such a provision, while useful to all teachers who might ultimately teach in evening schools, would be

of special value to teachers of Mathematics, Physics, and Chemistry. These men would be the more ready to appreciate what was required of them, and be able to take such steps as would make their subjects at once attractive and of direct utility to those engaged in industrial operations.

Meanwhile, much might be done to help both classes of teachers by the issue of special circulars containing clear statements as to the objects to be attained, and suggestions as to methods of teaching. For this purpose the local authorities can command expert assistance. In the case of a new subject—Practical Mathematics, for example—short courses of instruction would be of considerable advantage in smoothing the way and avoiding much ineffective experiment. Finally, the whole movement towards an improvement in methods of teaching would stimulate professional zeal and provide an impetus which would react vigorously upon reorganisation.

II.—*Buildings.*

Arguments for a more vigorous and systematic development of Evening Technical Education are often met by the complaint that suitable buildings are not available, and this forms a frequent excuse for inactivity. Notwithstanding the number of Technical Schools that have sprung up during the last twelve or fifteen years, there are still many places where classes are held in Elementary Schools which are not adapted for the older class of students, nor conveniently arranged for the type of instruction. In the absence of Technical Schools, Secondary Schools, where centrally situated, are often made use

of; but this plan, while possessing many advantages, is not carried out without difficulties. The headmaster of such a school is a teacher who is not primarily interested in problems of Technical Education. Moreover, both he and his staff are usually fully employed. The question of general supervision is of considerable importance, and while the headmaster is often unable, from want of time or other cause, to exercise direct supervision himself, the installation of an outsider is not a very satisfactory solution. Yet supervision is absolutely essential. In no other circumstances can the curriculum of the Evening School attain the unity of design and clearness of aim that is a necessary precursor of its recognition as an efficient portion of the educational machinery of the country. Nominal superintendence is of no use; real, active, vigorous control is a *sine qua non.*

The difficulty would probably be best met by strengthening the science staffs of secondary schools, and appointing a well-qualified science master who would act as the headmaster's deputy in regard to evening classes. Work done in this way should count as equivalent to a certain amount of day duty—the evening work would be an essential, to be treated seriously, and the connection between the evening work and the day work would react beneficially on each. Recent criticisms[1] of the employment of Secondary Schoolmasters in evening schools are based mainly on the work being regarded as an extra, undertaken in order to eke out a meagre salary. If an equivalent amount of time is allowed

[1] Report of Central Welsh Board. Also Mr. Sadler's Report on Secondary Education in Liverpool.

off duty during the day, it is not easy to see where the harm comes in. The teacher would meet a fresh class of students, many of them probably his old pupils; he would deal with the larger minds and wider views of those who were earning a living in the great industrial and commercial world, on the outskirts of which he lives; and he would go back to his day-boys with clearer knowledge, greater insight, a more just appreciation of the aims of education, than he could obtain in any other way.

Before leaving this question, it may be desirable to indicate a special case which might be solved in a particular way. Suppose there is a town of from 25,000 to 35,000 inhabitants, with a considerable engineering or mining industry, and witn a fair amount of building going on. Let it be assumed that from 120 to 200 students can be relied upon to present themselves annually for instruction, and that in the absence of a Technical or convenient Secondary School, the classes are held in an Elementary School. The absence of local teachers of high qualifications, and the disadvantages of a travelling teacher, even if one is available, stand in the way of any extensive development, while there is no one able or willing to undertake the post of principal teacher. The latter post would involve a considerable amount of time, but could be well filled by a man appointed for the purpose, and himself teaching on (say) four evenings a week. The committee, however, feel that they could not undertake to pay a well-qualified man (say) £200 to £250 for six months' work. How is this problem to be solved?

Let us suppose, now, that one of the engineering firms would be willing to have the services of such a man during the summer months, and to pay half his salary, leaving him free to act as headmaster of the Evening School during the winter. The firm would gain by having a man with better theoretical qualifications than the average draughtsman for special work during a portion of the year, while the school would gain by having a highly qualified teacher who was *in close touch with the local industry.*

Lest this suggestion should appear a counsel of perfection, it may be noted that Messrs. W. H. Allen & Sons, Queen's Engineering Works, Bedford, regularly employ a man to give instruction to their apprentices; and it is customary in American works to employ a man to exercise general oversight over the workshop progress of the apprentices. The plan has some advantage over that in which one man is required to give instruction in all the subjects which may be necessary, and would be well worth consideration.

Most Secondary Schools are now provided with Physical Laboratories, which, with a small outlay, would be suitable for practical work in Applied Mechanics and Steam, where separate laboratories are out of the question. The teaching of these subjects, however, would be rarely in the hands of one of the day school staff, and dual responsibility in a laboratory is to be avoided as far as possible. The effective oversight of the headmaster or head teacher in the Evening School would minimise the difficulties.

School woodwork shops require little modification

to render them suitable for practical exercises in illustration of Carpentry and Joinery, and Plumbers' Shops are springing up all over the country. In neither case is the cost of maintenance high. The difference between the price of the lead at the commencement of the session and the amount obtained for it at the end of the session, for a class of twenty students in Plumbing, need not be more than £3. Practical work in Bricklaying and Masonry might be carried out in a builder's yard on Saturday afternoons during the winter, or in the evening during the summer months. Co-operation between the employers and the school authorities in this way seems feasible, and would be of very great value.

School metal-work shops are scarce, and it is doubtful whether they would be of much value for technical students. There might be sufficient apparatus of a suitable character to demonstrate the simpler processes of forging and hardening tools, the use of the surface-plate and scribing-block, and other matters that can be treated in an educational manner. But, as a rule, the machine tools would be of such a different character to those found in a modern machine-shop that the scope of the work would be strictly limited. More difficult and complicated processes would be more effectively dealt with in the works, and here, again, the cordial interest which the employers are displaying suggests that they might afford facilities for occasional demonstrations during working hours. Such a course would help to develop that interest in his labour which not only makes a man a better workman, but also makes a workman a better man.

The combination of a Secondary Day and Evening Technical School is only to be recommended when separate institutions are impossible. The chief difficulty which militates against the establishment of small Technical Schools is the relatively small income upon which they must relie. They are only used for three or four hours a day against seven or eight in the case of Secondary Schools; the Government grant and fees are much less in proportion to the time they are occupied; and but few of them are endowed. Where small Technical Schools have been built by a loan on the security of the local rate, the annual sum available for Technical Instruction has been reduced by the repayment of loan and interest. For thirty years or so the school must bear the burden of bricks and mortar; teachers must be paid inadequate salaries, and their work seriously hampered by want of apparatus. The value of the work done depends less upon external appearance than it does upon the internal facilities and the spirit that animates the instruction.

The cost of evening technical instruction is a matter of some importance, and it is unfortunate that there appears to be no published figures in regard to it. The writer has before him three balance sheets from which the approximate figures given below are taken.

School.	County Council Grant.	Penny Rate.	Government Grant.	Fees.	No. of Students under instruction.	Cost per Student.
A	£410	—	£650	£250	500	£2 12 0
B	340	£220	220	100	250	3 10 0
C	250	—	170	50	250	1 18 0

"A" is a well-equipped and well-organised Technical School in an engineering town of nearly 50,000 inhabitants. The building is paid for. "B" is a small Technical School in a town of under 20,000 inhabitants. The local industry does not offer scope for development of Science and Art instruction; the building is fairly well equipped, and the work well organised; and £120 a year is required for repayment of loan and interest. "C" is a "school" by courtesy only. The classes are held in elementary school buildings, poorly equipped, and without pretence to organisation. There is a considerable amount of Engineering in the neighbourhood. The amount of Government grant per student in the three cases is not a bad measure of the efficiency. "A" and "C" are directly comparable, while "B" labours under much more serious disadvantages than do the other two. On the whole, it may be said, from a consideration of a number of examples, that Evening Technical Schools can be conducted efficiently on an expenditure of about £3 per head. In very small towns the cost may be higher, because the staff is not working at its full capacity: the same salary paid to the teacher who gives instruction to ten students would suffice for twenty students.

Introduction of Systematic Courses of Instruction.

The first step towards reorganisation is to secure the co-operation of the employers. They must be shown that the new arrangement is to their advantage. In this connection it is a matter for regret that conferences often come to no conclusion owing to the

absence of definite proposals and lack of knowledge of what is being done elsewhere. The ground might be prepared by first issuing a circular containing information similar to that in Chapter V.; and the MS. of this portion of the book has been used in one case with excellent results. The employers might be asked to indicate their preference for one or other of the schemes: a subsequent conference between them and the Education Authority would probably lead to agreement upon some definite scheme of co-operation.

The institution of a standard of admission would necessitate a distribution of students between the Continuation and Evening Technical Schools; but this could be effected gradually, and need not concern those who have already attended the classes for one or more years under the old regime. There is no reason to believe that insistence on courses of instruction would lead to any reduction in the number of students; indeed, in the example mentioned above, in which the influence of the employers was obtained, the number rose. If the students are told that the change is for their benefit, if the courses are advertised as a whole, meeting at certain hours on certain days of the week, unpopular subjects being hidden under the general title of the trade, and a composition fee charged for the course, there would not be much difficulty in getting them to attend. Regularity would be encouraged by confining privileges in the works and the school to those who took the course and made the highest average all-round attendance.

A matter of considerable importance is the number

of students necessary for systematic courses. Twenty students from one industry will often be the lowest where a single school is under consideration. With a hundred students in three industries, a three years' course could be carried on without difficulty. The larger classes in subjects common to the first year—such as Mathematics and Geometry—would compensate for the smaller classes in certain third year subjects. Moreover, in Drawing, second and third year students can often be taught concurrently when the numbers are not large. Again, if the annual influx of new students was small, or the teaching staff limited, a first year course could be commenced in alternate years; a case of this sort has actually occurred. In fact, there seems to be no reason for the existence at any time of the single class in Machine Drawing, Building Construction, or Mining, when the problem of the supply of teachers has been satisfactorily solved. If it is possible to teach one subject to ten students on fees and grant from various sources, it must be possible to teach four subjects to the same number; subscriptions to evening technical classes are rare, and, when given, are usually devoted to prizes.

It must be borne in mind that many districts consist of a number of small towns connected by frequent trains or trams, and what might be impossible when each school was considered alone becomes easy when the district is organised as a whole. In such cases there would be a considerable number of schools providing instruction in the first or first and second year's courses. Students who had passed successfully through these would be concentrated

in a smaller number of schools, in which they could continue their systematic studies. The scheme for Technical Exhibitions of the Yorkshire (W. R.) County Council (p. 154-9) provides for an arrangement of this sort within the area under their control, and the South Wales Coalfield is another district which presents many opportunities for a similar organisation.

The effect of all *special* education is more or less narrowing in character. When this has to be acquired during leisure hours, it is particularly important that the organisation and methods of instruction should lead as directly as possible to the goal. Still, it is quite possible to liberalise the training without decreasing its special value. To this end there should be a connection between the Free Library and the Evening School, and it ought to be the duty of the teachers to indicate the sources to which an earnest student may look for freer treatment and fuller information.

The smaller centres, in places where there is no Free Library, should be supplied with a small collection of books. Those bearing on the work of the classes should be of two kinds: there might be a few standard text-books for the use of the teachers and advanced students, and there might also be a few books in which the dry bones of fact, formula, and theory are clothed with literary grace, and vivified with the imaginative spirit. Thus engineering classes should not only be provided with a few standard works on Machine Design, Applied Mechanics and Steam, but also with some of the excellent popular works on engineering

triumphs, and the biographies of famous engineers. An outlay of £10 would provide from fifteen to twenty volumes, and these ought to be considered as essential as apparatus.

This special library should be supplemented by weekly and monthly papers and magazines. The cost could be met out of the composition fee, and it would not be difficult to dispose of the magazines at half-price. A room should be set apart for the use of such students as have few facilities for study or home work in their homes or lodgings. The school would thus gradually acquire the character of an institute, and exercise thereby a greater hold over the students.

There is a considerable field for University extension and other lectures in connection with Evening Schools, and it is unfortunate that they are frequently under different management. Among the results of this independence have been unsuitable choice of subjects, and considerable interference with the work of the schools. The educational value of University Extension work might be much increased by its closer association with the Evening School, and the time-table of the latter should be framed so as to allow of the students enjoying the benefits of the lectures with the least possible disturbance of the systematic instruction. However, to pursue the various methods of rendering Evening Schools more efficient in relation to those activities not directly concerned in obtaining a livelihood would be to step outside the province of this book, the main object of which has been to discuss the merits, defects, and improvement of such

schools from the point of view of Systematic Technical Education.

Of the ultimate success of well-devised schemes of instruction, or of their value to industry, the writer has little doubt. A long familiarity with evening students, particularly with those engaged in the trades considered, has convinced him that there is no more hard-working set of men in the community. Ill-assorted, and often ill-prepared they may be, groping in the dark, and feeling their way by such landmarks as are dimly visible; but still earnest, painstaking, willing to take advice, ready to "scorn delights and live laborious days," prepared at any sacrifice to grasp the opportunities held out to them, and to play their part in the industrial conflict which threatens every year to rage more furiously among the nations. The possibilities of Technical Education were never more clearly seen than when John Tyndall, speaking in London in 1879, pointed to "the intellectual Samsons toiling in the mills and at the forges of Lancashire and Yorkshire," and said: "Give those men the teachings of Science, and you will multiply the chances of discovery, diminish the causes of calamity, and materially enhance the prospects of national advancement."

APPENDIX

A. THE COST OF COMPULSORY CONTINUATION SCHOOLS.

B. NOTE ON MINING INSTRUCTION.

C. THE PROVISION OF APPARATUS.

A. The Cost, etc., of Compulsory Continuation Schools.

In view of the public interest which at the present time is exhibited in a system of Compulsory Continuation Schools, it may be useful to make a rough calculation of the cost of the plan outlined in Chapter II. Taking the figures[1] for 1902-3, we find that the number of scholars in Elementary Schools between certain limits of age was as follows:—

Between 12 and 13, - - - - - -	557,868
" 13 " 14, - - - - - -	351,288
" 14 " 15, - - - - - -	53,010

In round numbers, therefore, 206,000 children leave school at 13 years of age and 300,000 at 14. According to the scheme, the former would be required to attend the Continuation School for 4 years, and the latter for 2 years. Assuming that the scheme were put into operation generally, the following numbers would have to be provided for during the first four years:—

1st Year, - - - - - - - -	500,000
2nd " - - - - - - - -	1,000,000
3rd " - - - - - - - -	1,200,000
4th " - - - - - - - -	1,400,000

[1] Board of Education: Statistics of Public Elementary Schools, etc., Table 2.

The last number represents the number of children for which accommodation would ultimately be required, subject to any change due to raising the standard of exemption from attendance at the day school, and an increase in the population. It is interesting to note that the number of students under 15 years of age who attended an evening school during the session 1902-3 was 147,191. Ignoring the fact that not more than 40 per cent. or 50 per cent. were in regular attendance throughout the year, it is evident that not more than about one-tenth of the available material comes under the influence of the evening school, and taking the average attendance into account, only 5 per cent. of the children who leave school under 15 continue their education.

The next question is the cost of providing education for these children. The average cost of maintenance in Elementary Day Schools throughout the country is about £2 14s. per child.[1] The elementary day school meets for $27\frac{1}{2}$ hours a week, the evening school may be assumed to meet for 6 hours a week. Assuming the cost for heating, cleaning, and teaching to be proportionate (that for lighting would be a little more), the cost in evening schools would be roughly two-ninths of the cost in day schools for the same length of time. As, however, the evening school session is six months as compared with nine months in the case of the day school, the cost would be $\frac{2}{3} \times \frac{2}{9} = \frac{4}{27}$ of the cost in the day school. This gives 8s. per head. In order to allow a margin, and make the argument safer, the cost may be put at 10s.

Now, in any system of Compulsory Continuation Schools, certain exceptions have to be made Moreover, as the difficulties of securing regular attendance will be greater, it will not be advisable to calculate on a greater average than 70 per cent. The total cost to the nation, then, would be that of 1,000,000 children in average attendance at 10s. per head, or £500,000.

In making an approximate estimate of the effect on the rates, it will be simpler to omit any amount due to capital charges,

[1] The amount for 1902-3 is not available owing to changes brought about by the Act of 1902. The amount for 1901-2 was £2 13s. 2d.

which are necessary in any case. The figures below refer to 1901-2.[1]

Cost of Elementary Education under School Boards in England and Wales, omitting Capital Charges and Repayment of Loans.

Maintenance, - - - - - -	£8,194,789
Administration, - - - - - -	530,380
Miscellaneous, - - - - - -	250,773
Total, - -	£8,975,942

Of this amount, which may be taken as £9,000,000, 60 per cent. comes from the rates and the rest from fees, grants, etc. Assuming the same proportion to hold in evening schools, the amount required from the rates would be £300,000, and from the Board of Education, £200,000. Taking the average rate throughout the country to be 1s., of which 16 per cent. is expended in Capital and Loan Charges, the remaining 84 per cent., or a 10d. rate, produces £5,400,000. The £300,000 required from the rates therefore represents an increase of a little more than a ½d. in the £ over the School Board areas as they existed in 1901-2.

The foregoing estimate has been based on the figures for Elementary Education rather than on figures for the cost of evening schools, because the work of such schools as are under consideration would be essentially elementary, carried on in elementary school buildings, by elementary school teachers. The lack of efficiency and economy under the voluntary evening school system renders the present cost unsuitable as a basis for estimation. Two points, however, call for attention. The staffs of elementary schools are in part pupil teachers who could not be employed for evening work, and it would be extremely undesirable to clog the machinery of evening schools with the large classes that obtain in elementary schools. Since the chief item of expenditure would be salaries, a universal efficient compulsory system of evening schools would cost nearly £1,000,000 per annum. This would correspond roughly to a 1d. rate levied by the local authorities and an increase of

[1] Report of the Board of Education for 1902-3, p. 41.

about 4 per cent. in the Exchequer grant, assuming that the proportions given on a previous page hold for these schools. It must be emphasised, however, that no one contemplates an immediate and universal establishment of compulsory evening schools, and a comparatively small outlay would permit of much useful experiment, and help to form public opinion on the subject.

Opponents of compulsory evening schools frequently put forward the difficulty of enforcing the law as an argument against the institution. Under the scheme suggested, *permission to leave school below fifteen would be granted as a privilege, and on conditions which must be fulfilled.* If attendance at the evening school subsequently is unsatisfactory, the child forfeits the privilege and becomes *ipso facto* a truant, to be dealt with in the usual way. Instead of destroying parental responsibility, which as a matter of fact is frequently bartered for the few shillings a week which the child can earn, the scheme would stimulate this virtue. To retain the privilege, the parent must exercise control over the child.

Again, those who would oppose compulsion on the ground that the child is too tired after the day's work to undertake mental exercise must, if they are to be consistent, object quite as strongly to gymnastics, football, cricket, and other pastimes. For it may be asserted most emphatically that the change from the workshop to the school is no more tiring than a prolongation of bodily exertion. Finally, the moral effect of an extension of school discipline at this period of life, and during the winter months, outweighs in value nearly all other arguments from the point of view of national welfare as opposed to individual interests.

B. Note on Mining Instruction.

In support of the view that the Mining student should undergo instruction in a group of subjects, it will be useful to give a typical Home Office Examination Paper for the Colliery Manager's Certificate. The Paper selected was set by the Stafford District Board in April, 1903, for First Class Certificates.[1] It may be left to any competent critic to say whether

[1] Reprinted, with permission, from *Mining Engineering*, November and December, 1904.

suitable preparation for an examination of this breadth can be secured by one teacher giving one lesson a week, unless the standard is so low as to render the whole proceeding a farce.

PAPER I.

Ventilation.

1. How would you ventilate a sinking shaft (*a*) during sinking operations; (*b*) during walling operations? Illustrate your answer by sketches.

2. What means would you adopt to ascertain if the ventilation of a mine, working with naked lights, was adequate?

3. Describe, with sketches, some suitable arrangements of air-lock to enable winding operations to be conducted at the surface of an upcast shaft so as not to interfere with the ventilation of the mine.

4. Describe how you would remove an accumulation of fire-damp from a pair of rise working places 100 yards long, inclination 35°, with thurlings every 10 yards, containing brick stopping with the exception of the one adjacent to the face, stating what precautions you will adopt.

5. What observations and data are required to determine the quantity of air circulating in a mine, and the efficiency of the ventilating appliance?

6. What is ankylostomiasis? In what district has it recently been prevalent, and what precautions are necessary to prevent infection?

7. Ventilate the accompanying plan.

Gases and Lighting.

1. What is the composition of Marsh Gas how does it occur in mines, and what proportion is permissible in the atmosphere of the mine, and how is that proportion determined?

2. Sketch and describe the best Safety Lamp you know, defining in detail its various points and the best mode of testing before being issued to the men.

3. What do you consider the most reliable means of locking a Safety Lamp? Give your reasons.

Spontaneous Combustion.

1. If a sample of coal be finely powdered and hermetically sealed up in a vessel fitted with a gauge, one or other of two effects will be observed: either the gauge will indicate a gradual increase of pressure or a gradual diminution. Account for each of these effects and discuss their bearing upon coal mining.

2. In building off a gob-fire, which stopping would you complete first, the intake or return? Give reasons for your answer.

Geology.

1. In what formation does the Millstone Grit occur? Is coal found below this horizon in Great Britain; if so, where?

2. What dislocations and interruptions are seams of coal subjected to? Illustrate your answer by sketches.

3. Discuss the formation of coal, and name some of the principal fossils.

Ambulance.

1. A man receives a deep cut in the wrist caused by a fall of roof, spurting of blood is observed. What kind of bleeding is this, and how would you arrest it?

2. A man injured about the chest by a fall of coal complains of severe pain when breathing. What would you say was the matter with him, and what steps would you take to relieve the pain?

3. A man receives a severe electric shock, rendering him insensible. What means would you adopt to revive him?

PAPER II.

Machinery.

1. What is meant by the term Boiler Efficiency, and state the essentials of high efficiency?

2. What would you consider a good result from a Lancashire boiler 28′ long × 7′ diam.; the heat value of the fuel being 13120 B.T.U.?

3. What are the chief causes of priming in boilers, what are the dangers of priming, and what steps would you take to prevent priming?

4. What are the advantages of using superheated steam?

5. What are the respective advantages and disadvantages of using compressed air and electricity for transmission of power for colliery purposes.

6. What are the advantages of compound air compression where a press of 100 lbs. per square inch is required?

7. What size and type of winding engines would you employ for raising 125 tons of coal per hour from a depth of 800 yards with a boiler press of 120 lbs. per square inch?

8. Describe, with sketches, any system of expansion gear suitable for winding engines.

9. Describe any one mechanical coal cutter with which you may be acquainted, and state what are its chief defects.

10. Describe the essential features of the most efficient fan with which you are acquainted, and calculate the size of engine required to drive a fan circulating 200,000 cubic feet of air per minute with a W. G. of 5″.

11. Describe, with sketches, a direct acting and a 3-throw pump. Calculate the size of a pump to raise 224 gallons per minute through a vertical height of 600 feet, and state approximately power required.

12. What are the principal precautions to be observed for the preservation of winding ropes and the connections between the ropes and the cages. Which system of capping a winding rope do you prefer?

13. Describe the best system of signalling in underground haulage planes, and state what you consider a safe voltage for working electric signals in a fiery mine?

Sinking.

1. What are the advantages and disadvantages of simultaneous shot firing in a sinking shaft?

2. What precautions would you take to ensure the safety of the men where shots are fired simultaneously?

(*a*) By magnetic exploder.

(*b*) By current taken from lighting mains.

3. Describe and show by sketch the best system of coffering you are acquainted with, and state how you would deal with the feeders of water whilst the coffering was being put in.

4. What steps would you take to provide for a deep shaft being sunk perpendicularly, and give a sketch of the best arrangement for plumbing a shaft?

5. Describe the best sinking pump you are acquainted with, and give an account of the procedure of the work in a shaft where there is a large quantity of water.

Electricity.

1. What are the respective advantages and disadvantages of the following cables for underground use?

(*a*) Concentric.

(*b*) Ordinary rubber insulated, taped, and braided.

(*c*) Ordinary rubber insulated, taped, and armoured.

2. What are the principal causes of sparking at the brushes of a dynamo?

3. What are the causes of loss of efficiency in motors and dynamos? How would you calculate their electrical efficiency?

4. Describe the use of resistance coils in connection with the starting switch of a haulage motor.

5. Describe a Leclanché cell, and state its voltage.

6. State briefly a few of the rules you would suggest for the safe use of electricity underground.

PAPER III.

SURVEYING AND LAYING OUT A COLLIERY UNDER VARIOUS CIRCUMSTANCES.

Surveying.

1. Describe the mode of making a section across the surface and in the mine, with manner of keeping your field book.

2. What is the magnetic meridian? How is it fixed? What is its use?

3. If you had to survey a mine in which there was magnetic ttraction, how would you proceed?

4. How would you plot a fast needle underground survey?

Laying out a Colliery under Various Conditions.

Candidates unacquainted with the South Staffordshire Thick Coal Seam are not expected to answer questions relating thereto.

1. If you had a Colliery of parallelogram shape 30 chains iorth and south by 40 chains east and west, with a pair of hafts near the centre, with a seam of coal 3 feet 6 inches thick, iaving a fair roof and dry, and 4 feet above this coal a neasure of ironstone 3 feet thick, both coal and ironstone ising to the north at an angle of 8 degrees, describe, with ketches, the position of the roads, face of work, etc., and lescribe how you would work the coal and ironstone.

2. Suppose the above question to refer to the South Staffordshire Thick Coal Seam, say, 28 feet thick, describe, with sketches, how you would lay out the pit, and name the system upon which you would work the coal, and state why.

3. Suppose the last question to refer to the ordinary Thick Coal Ribs and Pillars of the South Staffordshire district, describe the mode of operations, with sketch.

4. If you had two coals as in section below, with an inclination of 30 degrees, describe how you would proceed to open the work, and what system of working you would adopt.

Roof—Bass.		
Coal	- - -	2 ft. 0 ins.
Spoil	- - -	3 ,, [illegible] ,,
Coal	- - -	3 ,, 6 ,,
Hard Fireclay	- -	3 ,, 5 ,,
Coal	- - -	2 ,, 0 ,,

5. Name the system of working the South Staffordshire Thick Coal, and describe the system or systems with which you are acquainted.

6. Name the different methods of working coals with which you are acquainted, and explain what circumstances

as to the nature of the floor and roof, and nature and thickness of the coal, are most suitable to each method.

PAPER IV.

Underground Management, Practical Ventilation, Timbering, Shot-firing, and General Knowledge of Explosives.

Candidates unacquainted with the South Staffordshire Thick Coal Seam are not expected to answer questions relating thereto.

1. What do you consider the duties of a Certificated Manager under the Coal Mines Regulation Acts? State the books, plans, certificates, and documents which it is requisite to keep to comply with the same Acts.

2. What number of stalls in a 3 feet 6 inches seam, worked on the Longwall system, should you place under the charge of one deputy?

3. State shortly the requirements of the Coal Mines Regulation Acts as to—

(*a*) The condition under which blasting can be carried on;

(*b*) The supply of timber;

(*c*) Ventilation.

4. Describe withdrawing timber from a road to be abandoned. Are any tools used? If so, describe them.

5. Are you in favour of systematic timbering? Describe any system with which you are acquainted. State in what way such a system is advantageous.

6. How are spontaneous fires caused underground? What are the first indications? And how should you deal with them?

7. In the South Staffordshire Thick Coal workings in one division show, by sketch, how you would fix the settings to prevent their reeling or being knocked out of place.

8. Make a sketch or sketches of the face timbering with which you are acquainted, and name the length and size of the timbers used.

9. On an Engine Plane with an accumulation of dust, where there was a fairly strong current and tubs are moved rapidly,

under what conditions and with what explosive should you allow blasting?

10. Name any permitted high explosives with which you are acquainted, and state their comparative power as compared with gunpowder.

11. Give the constituents of such high explosives.

12. State shortly the requirements of the last "Explosives in Coal-Mines Order."

C. The Provision of Apparatus.

It has been remarked (p. 288) that a comparatively small outlay on Apparatus would render a Physical Laboratory suitable for instruction in Applied Mechanics and Steam in those places where separate laboratories are out of the question. As there are probably about 300 Physical Laboratories as against 30 Laboratories for Applied Mechanics, and still fewer for Steam, available for evening students, an estimate of the cost may be useful.

Dealing first with Applied Mechanics, it may be assumed that the Physical Laboratory is already equipped with micrometer gauges, pulleys, spring balances, weights, levers, and inclined planes. In the list given below, the apparatus under Part I. is essential, that under Part II. desirable.

PART I.

	£	s.	d.
Derrick Crane,	£2	15	0
Wall Crane,	1	17	6
Roof Truss,	2	10	0
Sheer Legs,	2	15	0
App. for Expts. on Elasticity by Extension,	0	12	6
" " " Bending,	1	5	0
" " " Torsion,	2	10	0
" " " Compression, " " and Extension of Springs	0	15	0
Wheel and Axle,	1	15	0
Weston Differential Pulley Block,	0	16	6
Screw Jack,	1	5	0
	£18	16	6

PART II.

Ballistic Balance, - - - - - -	£6 10 0
Apparatus for Coil Friction, - - - -	1 15 0
,, ,, Breaking Steel Wires, -	5 15 0
,, ,, Measuring Centrifugal Force,	10 10 6
,, ,, ,, Efficiency of a Screw,	5 5 0
,, ,, ,, Energy of Rotation,	7 15 0
Model Crane with Gearing, - - -	9 15 0
Apparatus for Experiments on Beams, -	4 10 0
	£51 15 0

It should be observed that the comparatively small demand for apparatus of this sort considerably enhances the price, which is distinctly high. A good deal might be saved by having some of it constructed in the school workshop.

In regard to Steam, much will depend on the preliminary training of the students. If they have previously done no practical work in Heat, the resources of an ordinary Physical Laboratory will be ample for their requirements, but a Marcet's Boiler, costing about £3, should be obtained. Students at this stage should aim at securing clear notions of the properties of vapours, specific and latent heat, conduction and convection, and the mechanical equivalent. Beyond that they may be profitably employed in plotting curves of crank effort, and the motion of valves with various gears, with simple models. The cost of the latter is rather heavy: they are from £2 to £10 each; but the writer has seen many home-made models which serve the purpose equally well. A good deal of work might be done on the mechanism of the Steam Engine on an expenditure of £20 to £25. There can be no upper limit for either this subject or Applied Mechanics, and money spent in improving the equipment for these classes would be returned in the greater efficiency of the instruction.

In regard to the better provision of apparatus for all subjects at smaller centres, a wide field of experiment is opened out. Local authorities who have a number of classes under their control would find it an advantage to establish a store-room in which the more expensive apparatus would be kept, and

stributed to the classes according to a definite system. The gical order of treatment is of less importance in the case of plied than pure science, and if teachers knew at the com- encement of the session between what dates certain pieces apparatus would be in their possession, they could arrange eir work accordingly. The stores might have a workshop tached in which the old apparatus might be repaired, and w apparatus constructed according to the designs of teachers. his would enable the equipment to be kept up to date, and ovide a stimulus to the teachers which could not fail to react the value of their instruction. If one of the local authorities ould institute such a store-room and workshop for (say) a eriod of three years, they would be carrying out an experiment f no little importance.

A store-room of the kind described might perform another nction. It is well known that many manufacturers are willing supply samples of their work for a longer or shorter period the larger technical schools, and this is probably an excellent orm of advertisement. Smaller schools, with (say) 20 or 30 students per annum, cannot lay claim to the same consideration, hough cases are known in which applications from quite small entres have met with a ready response. The store-room with n adequate system of distribution would offer exceptional dvantages, and judging from an example which the writer has n mind, the offers might be so liberal as to call for the exercise of no little judgment in deciding what could be accepted. But, carried out intelligently, the plan would leave the best effect on eachers and students, and would contribute in no small measure to the closer union of Technical Education and Industry.

THE END

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